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AussieGRASS Environmental Calculator

User Guide Version 1.5

Remote Sensing Centre

May 2015

Queensland Government

Prepared by

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Aim

This document aims to provide AussieGRASS and FORAGE users with advice to interpret maps, graphs and other analyses. While the former Queensland Delbessie process has provided context for this User Guide, the recommendations could be used in many situations. Users are encouraged to develop their own interpreting skills by relating model outputs to their own knowledge base about specific regions.

A companion document “AussieGRASS Environment Calculator: Product Descriptions” provides detailed information of calculations for various outputs, and detailed caveats applying to each product. The “AussieGRASS Environmental Calculator – metadata” document provides detailed information for spatial (i.e. GIS) users of AussieGRASS products.

Document location: https://www.longpaddock.qld.gov.au/rainfallandpasturegrowth/index.php

Additional Resources:

- FORAGE reports: https://www.longpaddock.qld.gov.au/forage/
- Seasonal fractional cover: http://www.auscover.org.au/xwiki/bin/view/Product+pages/Landsat+Seasonal+Fractional+Cover
- Seasonal cover deciles: http://www.auscover.org.au/xwiki/bin/view/Product+pages/Seasonal+Cover+Deciles

1 Guide to Using AussieGRASS Map Products

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1.1 Introduction

AussieGRASS produces information at a 0.05° grid (5×5 km) as maps (gif files and postscript files), ERDAS IMAGINE ® rasters (these can be imported into Arc) and tables. The products are placed on the AussieGRASS website at the start of each month. These data are available as total amounts, percentiles and probabilities and include variables such as pasture growth, TSDM, potential stream flow, pasture cover, utilisation, rainfall and a probabilistic risk assessment for future pasture growth.

Identical AussieGRASS information is placed in several repositories:
(1) The internal DSITI website that is open to all DSITI staff.
http://atrax/longpdk/RainfallAndPastureGrowth/

(2) The external Long Paddock website.
http://www.longpaddock.qld.gov.au/rainfallandpasturegrowth/

(3) The Long Paddock AussieGRASS password protected area. This area services other states that subscribe to AussieGRASS.
http://www.longpaddock.qld.gov.au/aussiegrass/rainfallandpasturegrowth/

The current maps provide a recent (1 to 24 months) view of conditions influencing the land. Percentile maps (relative to historical records, *i.e*. from 1890 for rainfall and from 1957 for variables calculated from AussieGRASS) from previous years can be viewed to assess conditions prior to the current month. For a longer term view time-series maps, based on sub-IBRA regions, are probably easier to use

Characteristics of AussieGRASS outputs are:

- AussieGRASS map products are designed to give broad picture information on pasture growth, rainfall, total standing dry matter and a probabilistic risk assessment for future pasture growth.
- The model outputs are not correct at the property scale because input data for rainfall and stocking rates are not accurate at this scale.
- The information is best used in a spatial and temporal context for known locations.

Some activities that AussieGRASS maps are used for include:

- Assessment of likely future pasture growth to make decisions about stock management
- Assessment of areas where agistment might be possible
- Assessment of where there may be market opportunities for buying and selling animals
- Quantitative assessment of drought status
- Regional analysis of carrying capacity
- Marketing information for agri-business
- Reporting to State of Environment, ACRIS, and regional groups.

For Delbessie Agreement (SRLLS) and other applications maps may be used to:

- Provide context of current condition
- Provide historic context to assist decision making
- Identify trends
- Provide supporting information to validate assessment results
- Validate other products *e.g*. GCI (Ground Cover Index)

- Assist lessees through provision of management support tools and information

1.2 Rainfall Percentiles

Rainfall percentiles are derived from interpolated point data of monthly totals recorded at the Bureau of Meteorology's rain gauges. As only some rainfall data is reported to the BoM electronically and the remainder mailed in, the quality of rainfall data (hence maps) improves with time. Rainfall percentile maps provide a rapid view of likely on ground conditions (see *Appendix 6.2*).

In the monsoonal and coastal areas there can be significant reductions in rainfall without a large effect on pasture growth as in most years a significant proportion of rainfall just runs off. Therefore information other than rainfall alone is needed to make an estimate of pasture condition.

Where rainfall and or pasture growth is high it is less likely that there will be visible signs of overgrazing as pasture growth will very much exceed the rate of eating.

After several years of above average rainfall, look for species composition shifts, a classic example being the presence of black spear grass in Mitchell grass areas.

If the current rainfall percentile is high but growth low this means that pastures have not yet fully responded to the rainfall, as rain may have fallen late in the month or there may be other constraints to growth (*e.g*. nitrogen, temperature, radiation).

1.3 Pasture Growth Percentiles

Pasture growth percentiles are produced for 1, 3, 6, 12, and 24 months (although longer durations, such as 36 months, are now available for some AussieGRASS products). These maps show how the model relates recent pasture growth to all other years for this region (*see Appendix 5.3*).

It is probably most helpful to start at the longest period (24 months). The 24 month percentiles are the most reliable as they contain most data and are likely to be more meaningful than percentiles for periods less than 12 months. Only about 40% of the variability in pasture growth can be explained by rainfall alone. The temporal distribution of rainfall can be critical as can be soil moisture, ground cover and nitrogen.

Examine the maps to determine if the region you are interested in has pasture growth in the top or bottom categories. This indicates if pasture growth is exceptionally high or low. Twenty four months duration maps which display only 10th percentile growth indicate drought conditions on the ground and potential conditions for the weakening of pastures. A major implication of such a lack of growth and hence of fuel is the restricted opportunity to use fire as means to control woody weeds, i.e., the reduction in ground cover. Generally the larger the area in high or low percentile categories the more reliable the map as there are many rainfall stations contributing to the analyses.

Annual percentiles are the next most useful as they put the last 12 months pasture growth in context. Comparison with the 24 month percentiles gives some indication of the relative pattern of pasture growth.

Percentiles with durations of less than a year have to be interpreted with greater care especially if they cross seasonal boundaries. They may be used to assess the continuation of dry conditions or the onset of better or worsening conditions for percentile analysis periods during the growth season.

In seasons with naturally low growth, high and low growth expressed as a percentile can often be meaningless and a small amount of growth more or less than the average growth value can lead to a decile 10 or decile 90 percentile growth. In the AussieGRASS products these occurrences are masked as "seasonally dry" as these small amounts of growth have little relevance to pasture condition of animal production. In the growing season monthly percentile maps may be used to

assess the progression of the season and provide some information such as if a region is responding to rainfall.

1.4 Potential Flow to Stream

It is worthwhile noting that when assessing on ground conditions following very wet months, signs of water erosion can rapidly be hidden by lush growth and good ground cover. If rainfall percentiles suggest significantly above average rainfall conditions, examine potential flow to stream percentiles to ascertain if there have been significant runoff events that might be associated with soil erosion.

1.5 Drought Map for Queensland

The Department of Primary Industries regularly updates Queensland drought maps (*see Appendix 5.4*). The construction of these maps draws on a range of information such as independent declarations and information from field inspectors. The process for declaration and revocation can be complex and take into account factors other than rainfall (*e.g*. availability of water storages, economic condition of industry sector). In general terms rainfall has to be at the 5% level (1:20). Revocation is less well quantified and is based on return to normal conditions. Normal declaration and revocation rules mean that a system can be in drought more often than the one in 20 years that is suggested by the declaration rule alone. Current drought status and/or a recent history of declarations suggest a region will be in poorer than average condition.

1.6 Forecast Products

Forecast products with their associated statistical analyses are mainly designed for property management but might be used to schedule field work between different regions and to see if properties are likely to be trending toward better or worsening conditions. The statistical analysis should be consulted to see if forecasts have any skill. Pasture growth forecasts from AussieGRASS have skill additional to that from seasonal climate forecasts as it incorporates information on soil moisture and pasture condition. Pasture growth forecasts can be used the grazing industry to gradual climate change by managing stock numbers season by season.

Pasture growth forecasts incorporate water, temperature and nitrogen components and in wet years it is not uncommon to see a 10 percent change of exceeding median growth. This is because the model is indicating the system has nearly run out of nitrogen and that despite being green, little additional above ground pasture growth is likely to occur. In these areas it is likely that animal production will be less than expected because of low feed quality. It is useful to check pasture growth percentiles for the previous 12 months as there will have been an exceptional period of plant growth and total standing dry matter should be high. It is difficult to estimate nitrogen availability in wet years and the model may sometimes deplete soil nitrogen supply too early in the season.

1.7 Fire Products

These products are designed to help with fire management planning and give an indication of the curing state and amount of fuel.

1.8 Manipulating AussieGRASS outputs in ArcGIS

Most of the AussieGRASS outputs such as TSDM, pasture growth and fire product are available in ERDAS IMAGINE ® rasters (files with a suffix “img”). These “img” files can be viewed using ArcGIS, ArcView and other GIS software. If users want site specific stats for a specific property, shire or region, they can be derived by using tools provided in ArcGIS providing a shapefile (i.e. “shp”) or similar vector file is available for the area of interest.

In ArcGIS, click “Spatial Analyst Tools” from “ArcToolBox”, then click “Zonal”, you can select one of the tools to derive the stats. For example, if you select “Zonal Statistics As Table”, a window will pop up. In the “Input raster or feature data”, select the shape file for the property (or shire), and select one of the “img” file from AussieGRASS for the “Input value raster”. Then give a name for the output table and click OK, you will be able to generate the stats you need, which include max, min, mean, median among others. To view the content of the generated table, you need to add the table to ArcGIS using the same way you add other raster or vector data.

2 Guide to Using Sub-IBRA Time Series (Premium site)

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2.1 Introduction

Currently, IBRA version 6.1 is used by AussieGRASS. The boundaries of the Interim Biogeographic Regionalisation for Australia (IBRA), version 6.1, are illustrated in *Figure 2.1.*

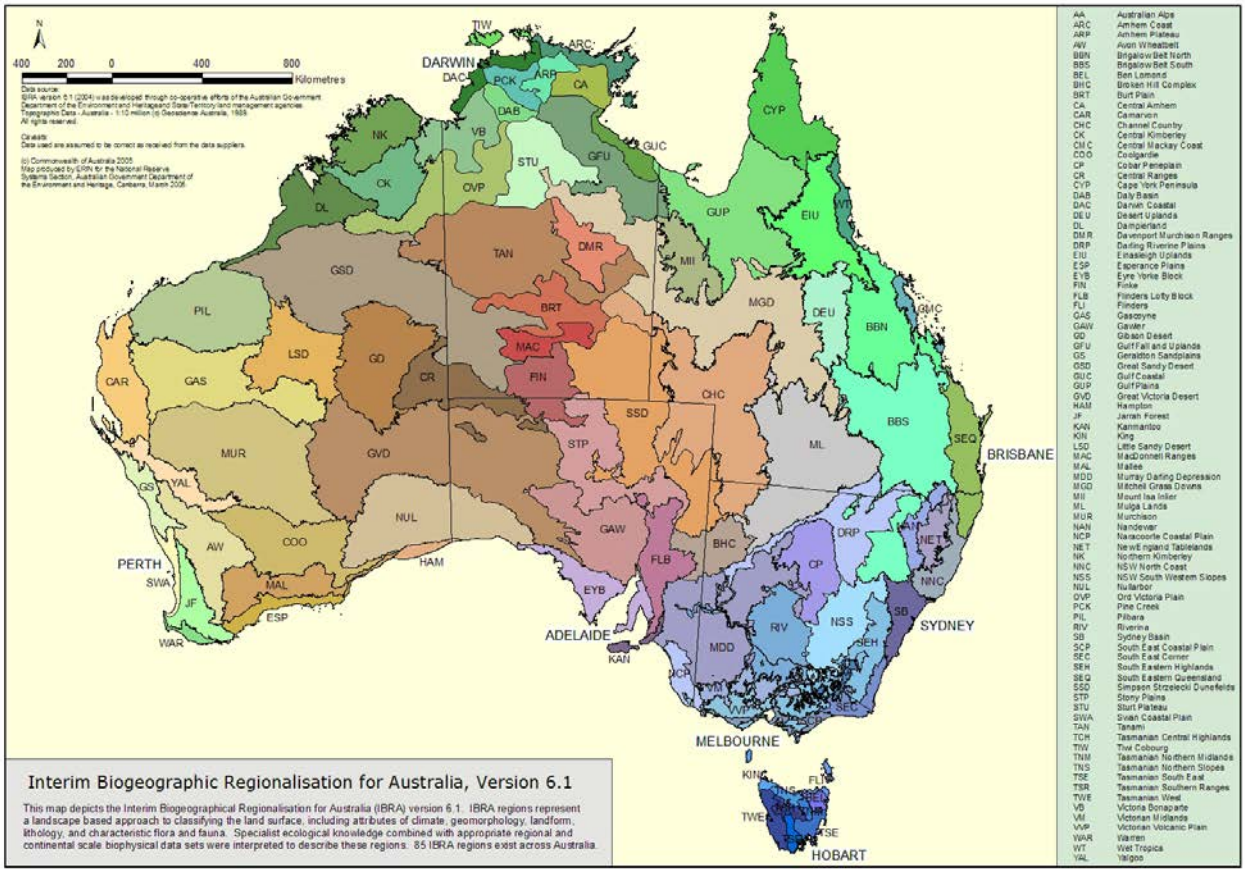

Interim Biogeographic Regionalisation for Australia, Version 6.1
This map depicts the Interim Biogeographical Regionalisation for Australia (IBRA) version 6.1. IBRA regions represent a landscape based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. Specialist ecological knowledge combined with appropriate regional and continental scale biophysical data sets were interpreted to describe these regions. 85 IBRA regions exist across Australia.
DARWIN
PERTH
ADELAIDE
MELBOURNE
SYDNEY
BRISBANE
HOBART

Figure 2.1: Map illustrating the Biogeographic Regions as represented in the IBRA (Interim Biogeographic Regionalisation for Australia), version 6.1. Source: Australian Department of Sustainability, Environment, Water, Population and Communities.
http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

Sub-IBRA areas are divisions within IBRA regions, illustrated in *Figure 2.2.* AussieGRASS produces information scaled to 5 km by 5 km pixels. Information is averaged for a sub-IBRA area and presented as either graphs, at two temporal resolutions, or as ascii files containing the monthly (or annual) average values for TSDM; growth; total cover; utilisation; maximum and minimum temperature; evaporation and rainfall, sorted by date. This time series product is updated between day 2 and day 7 of each month, with monthly plots showing an additional data point representing the previous month.

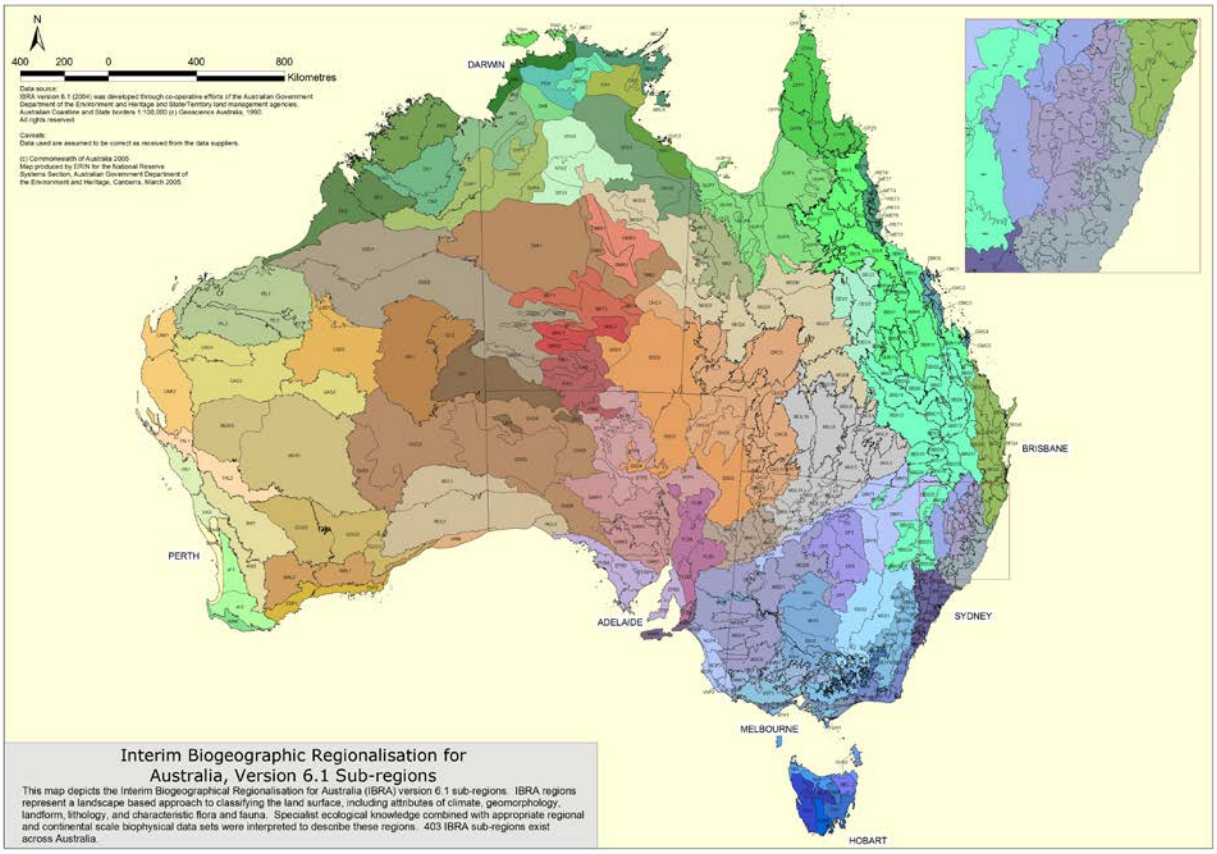

N
400 200 0 400 800
Kilometres
DARWIN
PERTH
ADELAIDE
BRISBANE
SYDNEY
MELBOURNE
HOBART
Interim Biogeographic Regionalisation for Australia, Version 6.1 Sub-regions
This map depicts the Interim Biogeographical Regionalisation for Australia (IBRA) version 6.1 sub-regions. IBRA regions represent a landscape based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. Specialist ecological knowledge combined with appropriate regional and continental scale biophysical data sets were interpreted to describe these regions. 403 IBRA sub-regions exist across Australia.

Figure 2.2: Map illustrating the Biogeographic Sub-regions as represented in the IBRA (Interim Biogeographic Regionalisation for Australia), version 6.1. Source: Australian Department of Sustainability, Environment, Water, Population and Communities.
http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

The purpose of these graphs is to give context to current conditions in the region, to compare preceding and historical information. Product derivation and descriptions are given in more detail in the individual product description documents (*e.g*. AussieGRASS Rainfall Products and Rainfall Outlooks; AussieGRASS TSDM; AussieGRASS Pasture Growth; AussieGRASS Ground Cover Products, and AussieGRASS Pasture Utilisation).

The aerial extents of sub-IBRA regions make averaging AussieGRASS model outputs across those regions appropriate as the calculated mean value approaches the “true” value at about this scale. Use of a mean value for a large area implies that about half the properties within each

region are above the sub-IBRA “average” for each variable and the remaining half below. The graphs and ascii files that contain the data for the time series are available on the DSITI internal web service (http://atrax/MapTables/timeSeries/subibra/).

Spatial maps of current conditions can be found on the internal AussieGRASS website http://longpaddock.qld.gov.au/rainfallandpasturegrowth/index.php or for external clients http://www.longpaddock.qld.gov.au/rainfallandpasturegrowth/index.php

Files are sorted into folders matching their sub-IBRA code and are named with the sub-IBRA name (see *Appendix 5.1*). The product consists of sixteen plots and a map showing the location of the sub-IBRA, and is designed to be printed on two A4 pages. The pdf file contains a full compliment of maps available.

There are two time scales for all information, monthly and annual. Monthly and annual data are presented for the past 20 years and from 1890 to present, respectively. The monthly data shows the impact of each season in the time series. Monthly data from 1890 are not presented as the graphs are too crowded for display. Monthly data are available in tabular form by downloading the ascii file with the *out* extensions, *e.g. sub-IBRA_state.out.*

2.2 Regional Map & Time Series Plots

The regional map (*Figure 2.3*) shows the sub-IBRA in colour and the 2008 shire boundaries for QLD (or 2001 SLA boundaries in other states).

Ancillary data for each time series plot include the number of AussieGRASS pixels in the sub-IBRA region (1 pixel is about 2700 ha) and the date when the plot was produced.

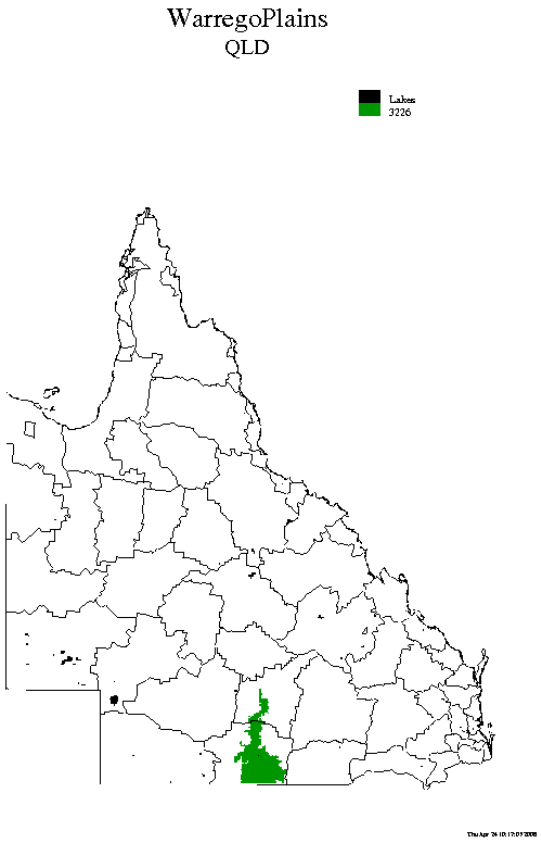


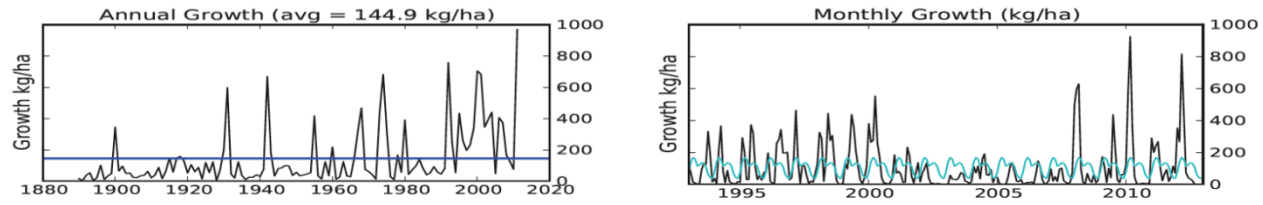
Figure 2.3: Map of Queensland with 2008 shire boundaries. The selected sub-IBRA (Warrego Plains) is shown in colour.

2.2.1 Pasture Growth

Growth is due to photosynthesis and in calculations it is accumulated over months or years. TSDM is the result of pasture growth and loss processes.

Pasture growth plots show the amount of monthly and annual pasture grown. The units are the same as TSDM (kg DM/ha). Examples of annual and monthly growth for Warrego Plains are shown in *Figure 2.4*. Low pasture growth broadly reflects the pattern of rainfall (although rainfall on its own explains only about 40% of the variability in pasture growth).

The pattern of rainfall and other parameters such as cover, soil water status, nitrogen availability, tree density *etc*., explain more than 60% of the variability in simulated pasture growth. A sequence of low growth years will leave pastures weak and vulnerable to species change. Impacts of flooding on growth are not simulated. Low growth can also occur in the late part of the wet season, due to nitrogen limitation, especially if rainfall is above average.



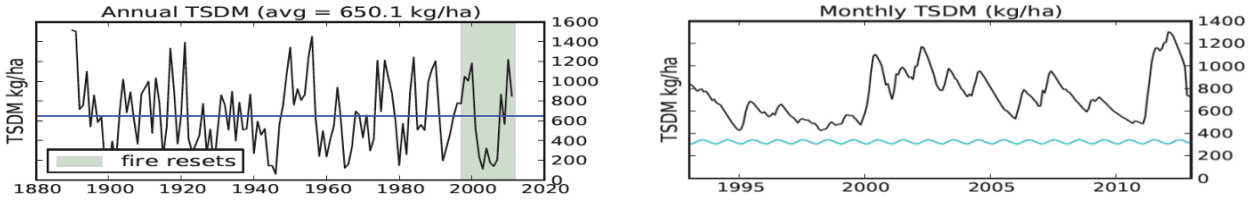
(a) (b)

Figure 2.4: Time series of (a) annual (growth.WarregoPlains_QLD.1890_2010.gif) and (b) monthly (growth.WarregoPlains_QLD.1988_2008.gif) growth (kg DM/ha) for the selected sub-IBRA (Warrego Plains).

2.2.2 Total Standing Dry Matter

Total standing dry matter (TSDM) is in units of kg DM/ha. TSDM is the average mass of all pasture (palatable and unpalatable) in the sub-IBRA region. 'Dry matter' is obtained experimentally by taking pasture cuts from field sites and drying in a fan-forced oven at 80^{o}C for a specified time period. Examples of annual and monthly TSDM for Warrego Plains are shown in *Figure 2.5.*

TSDM is the product of previous pasture growth and removals from detachment, grazing and fire. In locations like Cape York with near annual fire, TSDM approximates the previous wet season pasture growth while in some Spinifex systems the TSDM present may represent accumulations over the last decade or more. The patterns of TSDM should be somewhat similar to those of ground cover as ground cover is dominated by the TSDM component. Differences arise because TSDM often disappears faster than litter. In areas with woody weed issues one should look for accumulations of more than 1000 to 1500 kg/ha (fires are possible with more than this amount of standing fuel).



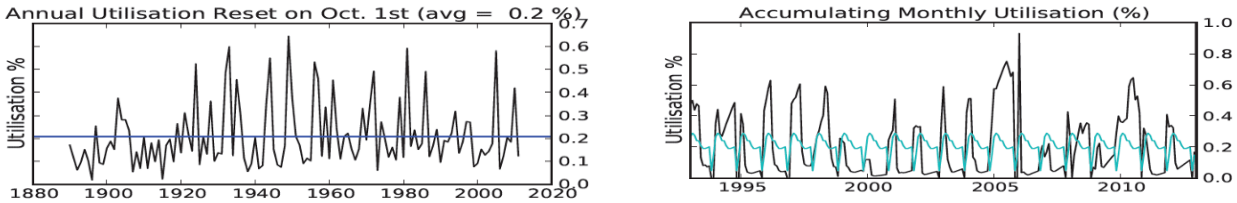
(a) (b)

Figure 2.5: Time series 1890-2010 for (a) annual total standing dry matter (TSDM) as kg DM/ha; and (b) time series 1988-2008 for monthly total standing dry matter (TSDM) as kg DM/ha, for the selected sub-IBRA (Warrego Plains).

2.2.3 Utilisation of current season's growth

There are a range of definitions for utilisation (e.g. Hunt 2008) and in this data we estimate of the utilisation of current seasons growth, with the assumption that animals will always eat current seasons growth (if available) rather than carryover.

Utilisation graphs show the ratio between growth and eaten (eaten/growth) where growth and eaten are accumulated monthly. Examples of annual and monthly utilisation for Warrego Plains are shown in *Figure 2.6.* Pasture utilisation is calculated only for grazed lands, as some sub-IBRA regions have significant areas of conservation reserves. Within areas grazed by domestic stock the pasture intakes of feral animals and macropods are added to domestic pasture intake. Utilisation rates include the impact of macropods, feral animals and domestic stock.


Annual Utilisation Reset on Oct. 1st (avg = 0.2 %)
Utilisation %
1880 1900 1920 1940 1960 1980 2000 2020
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Accumulating Monthly Utilisation (%)
Utilisation %
1995 2000 2005 2010
0.0 0.2 0.4 0.6 0.8 1.0

(a) (b)

Figure 2.6: Time series of (a) annual and (b) monthly % utilisation for the selected sub-IBRA (Warrego Plains).

The output is scaled between 0 and 100%, where 0 represents that "none of current growth (since 1st of October) is eaten" and 100% represents that "all current growth (since 1st of October) is eaten". The usual presence of carry over feed from season to season means that there can be quite an amount of pasture present despite high utilisation of newly grown material.

If no growth has occurred from 1st October utilisation will be set to zero as animals will be eating carryover from last season's growth. If a small amount of growth occurs, but is less than the amount eaten then utilization is set to 100%.

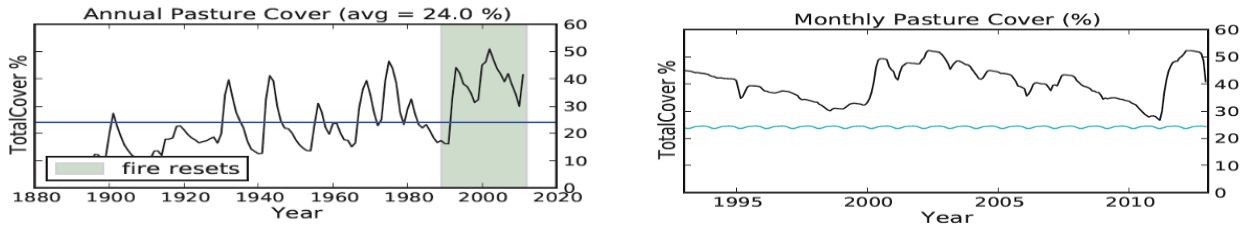
The start and end dates for utilisation calculations are somewhat arbitrary. Given the dominance of the summer wet season, growth and eaten are calculated from October 31st to September 30th for the annual plots. The monthly graph shows how the pattern of utilisation changes through the year. An early and good start to the wet season will start with low utilisation and trend higher as the season progresses. The reverse might be seen for a poor summer followed by winter rain. The monthly view of utilisation should be interpreted with care. One should look for multiple months (2-4) with high utilisation (> 80%) as this indicates that nearly all growth is being eaten.

The annual view of utilisation is useful for the estimation of potential current resource state. Back to back years of high utilisation are likely to lead to pasture degradation. Local recovery is possible if subsequent years with low utilisation allow pasture recovery. Extended periods of high utilisation, low cover and low growth tend to produce maximum degradation risk. Where there is little risk of erosion, high utilisation on its own can lead to changes in species composition.

2.2.4 Pasture Cover

The total cover plots are scaled in cover proportion (0-1) representing 0-100% ground cover (not bare ground). Examples of annual and monthly total cover for Warrego Plains are shown in *Figure 2.7a and 2.7b.* Cover response to rainfall is damped (slower changing) compared to pasture growth or TSDM as cover is also produced by litter. The cover value produced does not include the cover of the woody perennial component.

It is worthwhile examining cover levels over the past 4-5 years to see if they are tracking below the mean. By examining the annual graph one can determine how frequent low and high cover periods are on a century time scale. It is also possible to estimate where current cover sits relative to cover in benchmark periods (*e.g.* 1902-1903 drought, 1960's drought and the 1950's and 1970's wet periods). If the region has had extended periods of low cover then one could expect that some properties may show signs of soil loss (pedastalling, gully and sheet erosion, sand mounding *etc*.).



(a) (b)

Figure 2.7: Time series of (a) annual and (b) monthly total pasture cover (0-1) for the selected sub-IBRA (Warrego Plains).

2.3 Interpretation of Climate & Rainfall Plots

These plots are designed to inform users about the frequency and magnitude of climate variability that is due to natural processes operating over seasonal to decadal timescales *(Figure 2.8a and 1.8b)*. In some cases the data will be showing the first indications of climate change. This is apparent in some of the temperature trends displayed in the maximum and minimum temperature plots.

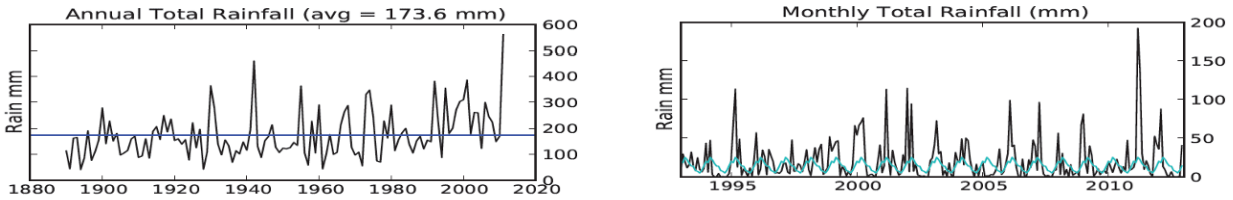
Climate and rainfall are averaged for the sub-IBRA regions. The averaging process uses interpolated data of climate and rainfall rather than individual station data. These surfaces are produced by SILO where statistical algorithms are used to take point data and produce rasters of rainfall, evaporation and temperature.

The density of rainfall and climate stations was quite low in the 1890s and was at a peak in the 1970s with over 800 and 7500 climate and rainfall stations, respectively across Australia, but has declined since then. Much of the data prior to 1957 remains archived on paper records. Records from only about 75 stations were used for the, “Computerising the Australian Climate Archives” project (CLIMARC). The low density of the network prior to 1957 resulted in different interpolation methods being used to produce gridded data and this data has a lower accuracy than post-1957 data. The former is coloured differently (red) in the climate graphs. In Western Australia data is essentially the long term average climate prior to 1910 as this state did not install Stephenson screens until this time.
(http://www.longpaddock.qld.gov.au/silo/CLIMARC/CLIMARCdocumentation.html).

Not all trends apparent in the climate data are real as individual station location and changes in the arrangement of nearby stations can cause trends to appear in the data. A classic example is the move of the evaporation pan from the Thargomindah Post Office to the Airport. This shift caused an apparent increase in pan evaporation rates (probably due to a change in exposure to wind). Thargomindah is the only pan for hundreds of kilometres in most directions and therefore this shift in location would cause apparent trends over many sub-IBRA units.

Increases in minimum temperature will be reflected in the number of frosts and browning off of pasture. While fewer frosts may increase animal production it may also increase the potential for over utilisation of pasture by animals concentrating on green pick for longer.

2.3.1 Rainfall



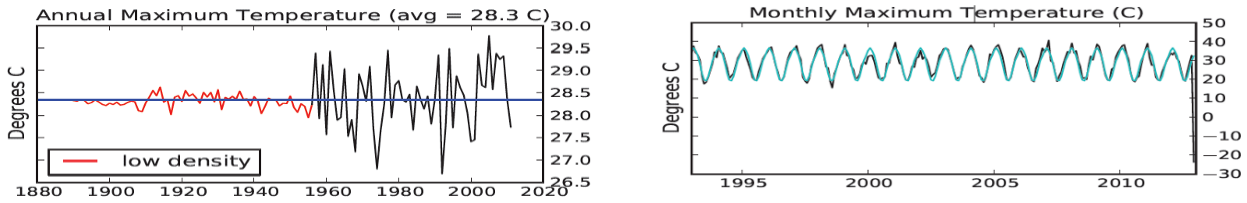
(a) (b)

Figure 2.8: Time series of (a) annual and (b) monthly rainfall (mm) for the selected sub-IBRA (Warrego Plains).

2.3.2 Temperature Plots

Both maximum and minimum temperature data are available. Examples of annual and monthly maximum temperature for Warrego Plains are shown in *Figures 1.9a and 1.9b.* Each plot consists of a time series and long term (1890 to present) mean data. In the case of the monthly graph *(Figure 2.9b)* the mean is a repeating sequence of long term monthly means for each month, while annual plots *(Figure 2.9a)* contain a flat line showing the long term annual mean. In the annual plots the data in black are real time data from 1957 onward, and the data in red is derived from the historical CLIMARC data (http://www.longpaddock.qld.gov.au/silo/CLIMARC/index.html).

The red CLIMARC data are synthetic estimates computed from solar radiation and vapour pressure deficit data. The formula does not include wind terms, so the CLIMARC evaporation values can be less variable than measured pan evaporation using equipment which came into operation from about 1970.

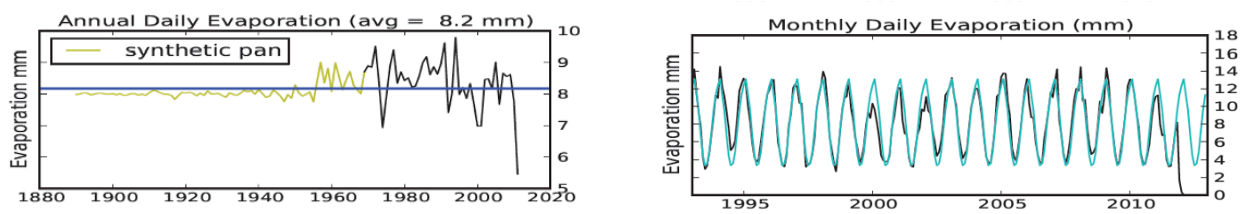


(a) (b)

Figure 21.9: Time series of (a) annual and (b) monthly maximum temperature (C) for the selected sub-IBRA (Warrego Plains).

2.3.3 Evaporation Plots

Examples of annual and monthly average daily evaporation for Warrego Plains are shown in *Figure 2.10*. Similarly, the evaporation time series consist of a red line and symbols to depict data derived from the interpolation of historical CLIMARC.


Annual Daily Evaporation (avg = 8.2 mm)
Evaporation mm
synthetic pan
1880 1900 1920 1940 1960 1980 2000 2020
10 9 8 7 6 5
Monthly Daily Evaporation (mm)
Evaporation mm
1995 2000 2005 2010
18 16 14 12 10 8 6 4 2 0

(a) (b)

Figure 2.10: Time series of a) annual and b) monthly evaporation (mm) for the selected sub-IBRA (Warrego Plains).

2.3.4 Ascii files

Each monthly and annual sub-IBRA time series is supported by the actual data as shown in the graphs. Table 2.1 shows a sample of the monthly data from the file AliceTableland_QLD.monthly.txt which can be imported into EXCEL for further analyses if warranted. Table 2.2 shows a sample of annual data from the file AliceTableland_QLD.annual.txt also in a spreadsheet format. Notes that describe headings and other important caveats are listed below.

Table 2.1 Example of monthly data from the file AliceTableland_QLD.monthly.txt

Year Mth Day	yyyymmdd	Date	Class	NPix	Area	max	min	evap	growth	tsdm	utilization	totalcover
1890 01 31	18900131	1890	3108	996	AliceTableland_QLD	31.4428	21.5279	6.2277	1450.5724	3557.0051	1.4587	0.6882
1890 02 28	18900228	1890.0834	3108	996	AliceTableland_QLD	31.8214	21.1457	5.9868	470.2053	3876.8096	1.9901	0.7467
1890 03 31	18900331	1890.1666	3108	996	AliceTableland_QLD	31.8185	20.265	5.645	168.1953	3879.4541	2.6935	0.7623
1890 04 30	18900430	1890.25	3108	996	AliceTableland_QLD	28.5332	16.3303	4.752	57.4426	3783.3223	3.1936	0.7633
1890 05 31	18900531	1890.3334	3108	996	AliceTableland_QLD	25.2994	13.0211	3.4307	10.1689	3652.2463	3.7464	0.7602
1890 06 30	18900630	1890.4166	3108	996	AliceTableland_QLD	23.3324	10.1766	2.8603	8.2642	3513.0437	4.2307	0.7549
1890 07 31	18900731	1890.5	3108	996	AliceTableland_QLD	22.4321	7.3956	3.1092	3.4854	3352.4497	4.7334	0.7512
1890 08 31	18900831	1890.5834	3108	996	AliceTableland_QLD	25.5068	8.3533	4.2825	1.0383	3174.9619	5.2364	0.7475
2007 04 30	20070430	2007.25	3108	996	AliceTableland_QLD	31.4981	16.4998	7.0957	1.1236	1183.147	24.7809	0.5273
2007 05 31	20070531	2007.3334	3108	996	AliceTableland_QLD	29.757	16.0042	5.3045	0.1334	1076.6233	27.9243	0.5209
2007 06 30	20070630	2007.4166	3108	996	AliceTableland_QLD	19.6009	9.5066	2.9282	295.0904	1274.5575	21.782	0.5165
2007 07 31	20070731	2007.5	3108	996	AliceTableland_QLD	22.4977	6.2627	3.5765	359.1442	1537.1884	17.7274	0.5562

Year Mth Day	yyyymmdd	Date	Class	NPix	Area	max	min	evap	growth	tsdm	utilization	totalcover
2007 08 31	20070831	2007.5834	3108	996	AliceTableland_QLD	25.2852	11.3701	4.479	118.8003	1556.6509	17.5009	0.5735
2007 09 30	20070930	2007.6666	3108	996	AliceTableland_QLD	30.3568	13.6109	6.0462	4.367	1451.328	19.1309	0.5724
2007 10 31	20071031	2007.75	3108	996	AliceTableland_QLD	33.8566	18.2962	8.4563	29.6133	1355.3669	67.8164	0.5637
2007 11 30	20071130	2007.8334	3108	996	AliceTableland_QLD	33.4494	20.0806	8.3416	233.383	1449.7373	25.2934	0.5532
2007 12 31	20071231	2007.9166	3108	996	AliceTableland_QLD	34.5463	21.8007	7.6871	409.8331	1715.6359	14.864	0.5619
2008 01 31	20080131	2008	3108	996	AliceTableland_QLD	32.5417	21.8144	6.2775	999.4802	2575.3784	7.0645	0.6156
2008 02 29	20080229	2008.0834	3108	996	AliceTableland_QLD	32.2055	21.6201	6.9246	695.6241	3387.3408	5.3886	0.6933
2008 03 31	20080331	2008.1666	3108	996	AliceTableland_QLD	31.3546	18.4881	7.0322	64.7428	3284.8735	6.0311	0.7222
2008 04 30	20080430	2008.25	3108	996	AliceTableland_QLD	29.9277	13.4335	6.047	0.6874	3076.7571	6.8908	0.7207

Table 2.2 Example of annual data from the file AliceTableland_QLD.annual.txt

YearMthDay	yyyymmdd	Date	Class	NPix	Area	max	min	evap	growth	tsdm	utilization	totalcover
1890 12 31	18901231	1890.9166	3108	996	AliceTableland_QLD	29.2991	15.4315	5.5208	2350.7598	3312.0762	16.8113	0.7399
1891 12 31	18911231	1891.9166	3108	996	AliceTableland_QLD	28.8754	14.5435	5.558	2950.1018	3723.4778	15.097	0.7668
1892 12 31	18921231	1892.9166	3108	996	AliceTableland_QLD	30.8876	15.3024	6.0709	798.6444	2096.3303	18.8049	0.6896
1893 12 31	18931231	1893.9166	3108	996	AliceTableland_QLD	30.5949	15.3194	6.1083	2178.2256	1749.7396	20.9816	0.6058
1894 12 31	18941231	1894.9166	3108	996	AliceTableland_QLD	28.9914	14.7823	5.5279	3234.9331	3104.7874	15.0827	0.7282
1895 12 31	18951231	1895.9166	3108	996	AliceTableland_QLD	30.1511	14.8822	5.8983	2226.2993	3432.3669	11.3413	0.7659
1896 12 31	18961231	1896.9166	3108	996	AliceTableland_QLD	29.8022	14.8523	5.9121	2131.4646	2688.3806	14.2065	0.7249
1897 12 31	18971231	1897.9166	3108	996	AliceTableland_QLD	30.9783	15.6279	6.1646	1270.3888	1736.4401	18.6223	0.6449
1998 12 31	19981231	1998.9166	3108	996	AliceTableland_QLD	30.6879	17.5094	5.6814	3143.2988	1747.5005	11.6794	0.5808
1999 12 31	19991231	1999.9166	3108	996	AliceTableland_QLD	30.1034	16.3782	5.5287	2312.2791	2768.9846	10.6851	0.7257
2000 12 31	20001231	2000.9166	3108	996	AliceTableland_QLD	29.0974	16.1443	5.539	3306.5701	2892.7576	13.2327	0.7233
2001 12 31	20011231	2001.9166	3108	996	AliceTableland_QLD	31.0287	15.8305	6.3557	1562.2567	2716.3762	14.9155	0.7278
2002 12 31	20021231	2002.9166	3108	996	AliceTableland_QLD	32.0102	15.9227	7.2312	898.0059	1667.9604	15.5368	0.6573
2003 12 31	20031231	2003.9166	3108	996	AliceTableland_QLD	31.552	17.0617	6.9781	850.8039	878.6638	41.2222	0.5159
2004 12 31	20041231	2004.9166	3108	996	AliceTableland_QLD	31.3333	16.541	6.6901	1013.475	850.6689	22.4631	0.4776
2005 12 31	20051231	2005.9166	3108	996	AliceTableland_QLD	31.4055	17.1767	7.1365	919.5959	779.8022	32.4161	0.4387

YearMthDay	yyyymmdd	Date	Class	NPix	Area	max	min	evap	growth	tsdm	utilization	totalcover
2006 12 31	20061231	2006.9166	3108	996	AliceTableland_QLD	30.504	16.634	6.7661	1463.8279	1061.0093	33.7563	0.484
2007 12 31	20071231	2007.9166	3108	996	AliceTableland_QLD	30.1455	16.5373	6.2625	2195.5974	1359.4659	26.4105	0.5395

Note: The headings for Table 2.1 and 2.2 are as follows:

- Year Mth Day: is expressed as the year (4 digits), the month (2 digits), the day (2 digits) – including gaps for splitting dates for analysis.
- yyyymmdd: is expressed as the year (4 digits), the month (2 digits), the day (2 digits) – no gaps

- Date: is expressed as a decimal which is useful for graphing purposes.
- Npix: no of 0.05 x 0.05 degree pixels as used in AussieGRASS
- max: maximum temperature (^{o}C)
- evap: evaporation (mm)
- TSDM: total standing dry matter (kg DM/ha)
- totalcover: total ground cover expressed as a proportion (0-1)
- Class: an internal GIS code associated with the area name
- Area: the sub-IBRA region that has been selected
- min: minimum temperature (^{o}C)
- growth: pasture growth (kg DM/ha)
- utilization: pasture utilisation (%)

- Some calculated values have trailing decimals (e.g. max/min temperature, growth) that are not accurate to the degree expressed.

QUESTIONS THAT AUSSIEGRASS MAY ASSIST WITH

- What conditions could I expect in the field: drought to boggy, large body of grass, little pasture present?
- Do rainfall and pasture growth indicate current good, poor or average conditions?
- Should perennial pastures or annual species be expected?
- Are conditions similar between regions, or is this an isolated spot with apparently different conditions to other similar regions?
- How long have current conditions been in place (extended dry, short wet etc)?
- How do the relative conditions compare to other places recently visited? (Rainfall maps and model outputs suggest that a property should be in better relative condition than another property that was just visited)?
- Is there any indication that there been any unusual events (flood or drought)? If wet, have there been any large runoff events that may have produced fresh evidence of erosion?
- Do the conditions experienced over the last few years suggest that the property should be in better or worse than expected condition for the district, remembering that under good management domestic livestock should not be contributing to poor conditions even under drought conditions?
- Do recent seasonal conditions mean that it will be difficult to observe any underlying land degradation?

3 Glossary

AussieGRASS - Australian Grassland and Rangeland Assessment by Spatial Simulation (Carter et al. 2000). http://www.longpaddock.qld.gov.au/about/researchprojects/aussiegrass/index.html

Ground cover/Bare ground – Ground cover refers the proportion of ground which is covered by green and dead foliage, cryptogram and detached plant litter. Bare ground is the opposite of ground cover and refers the proportion of ground which is either bare soil or covered by rock.

GRASP – A model of the climate-soil-plant-animal-management of perennial grasses of Northern Australia (McKeon et al. 1990).

Percentile - The percentile of a number indicates where the number lies in a set of numbers. For example, if last year's rainfall was ranked at the 30th percentile of the long-term annual rainfall record, then the rainfall in 30% of the years in the record are less than (or equal to) last year's rainfall and the rainfall in the remaining 70% of years in the record are greater than last year's rainfall. The percentiles that are multiples of 25 are called quartiles. The 25th percentile is the first quartile, the 50th percentile is the second quartile and so on.

SILO – web based climate databases provided by BoM and DSITI.

http://www.longpaddock.qld.gov.au/silo/

SLATS - Statewide Landcover And Trees Study, a research project conducted by the Remote Sensing Centre, Queensland Department of Natural Resources and Water (now DSITI) on assessing land clearing and vegetation density. https://www.qld.gov.au/environment/land/vegetation/mapping/slats/

TSDM - Total standing dry matter, refers to the aboveground total standing green and dead plant material, but not including the plant litter, reported on a dry weight basis.

4 References

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5 Appendices

5.1 Sub-IBRA Names & Code Numbers

1001 NSW AustralianAlps
1038 NSW MoonieBarwonInterfluve
1039 NSW NorthernBasalts
1040 NSW NorthernOutwash
1041 NSW PilligaOutwash
1042 NSW Pilliga
1043 NSW LiverpoolPlains
1044 NSW LiverpoolRange
1045 NSW TalbragarValley
1054 NSW BarrierRange
1055 NSW MootwingeeDowns
1056 NSW ScopesRange
1057 NSW BarrierRangeOutwash
1067 NSW CoreRanges
1068 NSW Bulloo
1076 NSW TibooburraDowns
1083 NSW BoorindalPlains
1084 NSW BarnatoDowns
1085 NSW CanbelegoDowns
1086 NSW Nymagee
1087 NSW LachlanPlains
1115 NSW CulgoaBokhara
1116 NSW PooncarieDarling
1118 NSW WarramboolMoonie
1119 NSW CastlereaghBarwon
1120 NSW BoganMacquarie
1121 NSW LouthPlains
1122 NSW WilcanniaPlains
1123 NSW Menindee
1124 NSW GreatDarlingAnabranch
1201 NSW SouthOlaryPlain_MurrayBasinSands
1206 NSW DarlingDepression
1217 NSW UrisinoSandplains
1218 NSW WarregoSands
1219 NSW KerribreeBasin
1220 NSW WhiteCliffsPlateau
1221 NSW ParooOverflow
1222 NSW ParooDarlingSands
1224 NSW NebinePlains_BlockRange
1226 NSW WarregoPlains
1228 NSW CuttaburraParoo
1229 NSW WestWarrego
1233 NSW Nandewar_NorthernComplex
1234 NSW InverellBasalts
1235 NSW Kaputar
1236 NSW Peel
1241 NSW BundarraDowns
1242 NSW SevernRiverVolcanics
1243 NSW NortheastForestLands
1244 NSW TenterfieldPlateau
1245 NSW YarrowyckKentuckyDowns
1246 NSW BinghiPlateau
1247 NSW StanthorpePlateau
1248 NSW EasternNandewars

1249 NSW TinghaPlateau

1250 NSW Nightcap

1251 NSW RoundMountain

1252 NSW BeardyRiverHills

1253 NSW WalchaPlateau

1254 NSW ArmidalePlateau

1255 NSW WongwibindaPlateau

1256 NSW DeepwaterDowns

1257 NSW GlennInnesGuyraBasalts

1258 NSW EborBasalts

1259 NSW MoredunVolcanics

1262 NSW RichmondTweed_ScenicRim

1264 NSW NorthernInlandSlopes_UpperSlopes

1265 NSW LowerSlopes

1281 NSW Lachlan

1282 NSW Murrumbidgee

1283 NSW MurrayFans

1285 NSW RobinvalePlains

1286 NSW MurrayScrollBelt

1291 NSW EastGippslandLowlands

1292 NSW SouthEastCoastalRanges

1300 NSW SoutheastHillsandRanges_Murwillumbah

1301 NSW SouthernCoastalLowlands

1311 NSW StrzeleckiDesert_WesternDunefields

1312 NSW CentralDepression

1313 NSW BullooDunefields

1354 NSW Narrandool

1357 NSW Washpool

1358 NSW Cataract

1359 NSW Dalmorton

1360 NSW Chaelundi

1361 NSW Yuraygir

1362 NSW CoffsCoastandEscarpment

1363 NSW MacleayHastings

1364 NSW CarraiPlateau

1365 NSW MacleayGorges

1366 NSW UpperManning

1367 NSW ComboynePlateau

1368 NSW MummelEscarpment

1369 NSW Barrington

1370 NSW Tomalla

1371 NSW Ellerston

1372 NSW UpperHunter

1373 NSW KaruahManning

1374 NSW RockyRiverGorge

1375 NSW GuyFawkes

1376 NSW Kerrabee

1377 NSW Hunter

1378 NSW Capertee

1379 NSW Wollemi

1380 NSW Yengo

1381 NSW Wyong

1382 NSW Pittwater

1383 NSW Cumberland

1384 NSW Burragorang

1385 NSW SydneyCataract

1386 NSW MossVale

1387 NSW Illawarra

1388 NSW Ettrema

1389 NSW Jervis

1390 NSW Bateman

1392 NSW Monaro

1393 NSW Murrumbateman

1394 NSW Bungonia
1395 NSW Kanangra
1396 NSW Crookwell
1397 NSW Oberon
1398 NSW Bathurst
1399 NSW Orange
1400 NSW HillEnd
1401 NSW Bondo
1402 NSW KybeyanGourock
1403 NSW Woodenbong
1404 NSW ClarenceSandstones
1405 NSW ClarenceLowlands
2002 VIC VictorianAlps
2147 VIC WilsonsPromontory
2202 VIC MurrayMallee
2204 VIC LowanMallee
2205 VIC Wimmera
2237 VIC Bridgewater
2238 VIC GlenelgPlain
2264 VIC NorthernInlandSlopes_UpperSlopes
2283 VIC MurrayFans
2284 VIC VictorianRiverina
2285 VIC RobinvalePlains
2286 VIC MurrayScrollBelt
2288 VIC GippslandPlain
2289 VIC OtwayPlain
2290 VIC WarrnamboolPlain
2291 VIC EastGippslandLowlands
2292 VIC SouthEastCoastalRanges
2293 VIC HighlandsSouthernFall
2294 VIC HighlandsNorthernFall
2295 VIC OtwayRanges
2296 VIC StrzeleckiRanges
2338 VIC Goldfields
2339 VIC CentralVictorianUplands
2340 VIC GreaterGrampians
2341 VIC DundasTablelands
2342 VIC VictorianVolcanicPlain
2391 VIC HighlandsFarEast
2392 VIC Monaro
3012 QLD TownsvillePlains
3013 QLD BasaltDowns
3014 QLD IsaacCometDowns
3015 QLD NeboConnorsRanges
3016 QLD SouthDrummondBasin
3017 QLD MarlboroughPlains
3018 QLD BogieRiverHills
3019 QLD CapeRiverHills
3020 QLD BeucazonHills
3021 QLD WyarraHills
3022 QLD NorthernBowenBasin
3023 QLD BelyandoDowns
3024 QLD UpperBelyandoFloodout
3025 QLD AnakieInlier
3026 QLD ClaudeRiverDowns
3027 QLD CarnarvonRanges
3028 QLD TaroomDowns
3029 QLD SouthernDowns
3030 QLD Barakula
3031 QLD DulaccaDowns
3032 QLD WeriboneHigh
3033 QLD TaraDowns
3034 QLD EasternDarlingDowns
3035 QLD InglewoodSandstones

3036 QLD MoonieR.CommoronCreekFloodout
3037 QLD Woorabinda
3038 QLD MoonieBarwonInterfluve
3046 QLD BoomerRange
3047 QLD MountMorganRanges
3048 QLD CallideCreekDowns
3049 QLD Arcadia
3050 QLD DawsonRiverDowns
3051 QLD BananaAuburnRanges
3052 QLD BucklandBasalts
3066 QLD TokoPlains
3068 QLD Bulloo
3069 QLD SturtStonyDesert
3070 QLD GoneawayTablelands
3071 QLD DiamantinaEyre
3072 QLD CooperPlains
3074 QLD LakePure
3075 QLD NoccundraSlopes
3076 QLD TibooburraDowns
3088 QLD Whitsunday
3089 QLD ProserpineSarinaLowlands
3090 QLD ClarkeConnorsRanges
3091 QLD Byfield
3092 QLD Manifold
3096 QLD CoenYamboInlier
3097 QLD StarkeCoastalLowlands
3098 QLD CapeYorkTorresStrait
3099 QLD JardinePascoeSandstones
3100 QLD BattleCampSandstones
3101 QLD LauraLowlands
3102 QLD WeipaPlateau
3103 QLD NorthernHolroydPlain
3104 QLD CoastalPlains
3107 QLD PrairieTorrensCreeksAlluvials
3108 QLD AliceTableland
3109 QLD CapeCampaspePlains
3115 QLD CulgoaBokhara
3118 QLD WarramboolMoonie
3119 QLD CastlereaghBarwon
3125 QLD GeorgetownCroydon
3126 QLD Kidston
3127 QLD HodgkinsonBasin
3128 QLD BrokenRiver
3129 QLD UndaraToombaBasalts
3130 QLD HerbertonWairuna7324TanamiP1
3159 QLD McArthurSouthNicholsonBasins
3172 QLD KarumbaPlains
3173 QLD WellesleyIslands
3174 QLD ArmraynaldPlains
3175 QLD WoondoolaPlains
3176 QLD MitchellGilbertFans
3177 QLD ClaravillePlains
3178 QLD HolroydPlainRedPlateau
3179 QLD DoomadgeePlains
3180 QLD DonorsPlateau
3181 QLD GilbertonPlateau
3208 QLD BarklyTableland
3209 QLD GeorginaLimestone
3210 QLD SouthwesternDowns
3211 QLD KynunaPlateau
3212 QLD NorthernDowns
3213 QLD CentralDowns
3214 QLD SouthernWoodedDowns
3215 QLD WestBalonnePlains

3216 QLD WestBulloo
3217 QLD UrisinoSandplains
3223 QLD EasternMulgaPlains
3224 QLD NebinePlains_BlockRange
3225 QLD NorthEasternPlains
3226 QLD WarregoPlains
3227 QLD LangloPlains
3228 QLD CuttaburraParoo
3229 QLD WestWarrego
3230 QLD NorthernUplands
3233 QLD Nandewar_NorthernComplex
3244 QLD TenterfieldPlateau
3247 QLD StanthorpePlateau
3262 QLD RichmondTweed_ScenicRim
3269 QLD SouthwesternPlateausandFloodouts
3270 QLD Thorntonia
3271 QLD MountIsaInlier
3298 QLD BurnettCurtisHillsandRanges
3299 QLD MoretonBasin
3300 QLD SoutheastHillsandRanges_Murwillumbah
3301 QLD SouthernCoastalLowlands
3302 QLD BrisbaneBarambahVolcanics
3303 QLD SouthBurnett
3304 QLD GympieBlock
3305 QLD BurnettCurtisCoastalLowlands
3306 QLD GreatSandy
3308 QLD SimpsonDesert
3309 QLD Dieri
3311 QLD StrzeleckiDesert_WesternDunefields
3313 QLD BullooDunefields
3345 QLD Herbert
3346 QLD Tully
3347 QLD Innisfail
3348 QLD Atherton
3349 QLD PalumaSeaview
3350 QLD KirramaHinchinbrook
3351 QLD BellendenKerLamb
3352 QLD Macalister
3353 QLD DaintreeBloomfield
3354 QLD Narrandool
3355 QLD Debella
3356 QLD Jericho
4054 SA BarrierRange
4057 SA BarrierRangeOutwash
4069 SA SturtStonyDesert
4071 SA DiamantinaEyre
4073 SA Coongie
4074 SA LakePure
4093 SA MannMusgraveBlock
4094 SA Wataru
4095 SA EverardBlock
4133 SA SouthernYorke
4134 SA StVincent
4135 SA EyreHills
4136 SA Talia
4137 SA EyreMallee
4140 SA Tieyon_FinkeP3
4141 SA Pedirka
4142 SA MountLoftyRanges
4143 SA Broughton
4144 SA OlarySpur
4145 SA SouthernFlinders
4146 SA NorthernFlinders

4152 SA MyallPlains
4153 SA GawlerVolcanics
4154 SA GawlerLakes
4155 SA ArcoonaPlateau
4156 SA Kingoonya
4184 SA Eastern_Maralinga
4185 SA Kintore
4186 SA Tallaringa
4187 SA Yellabinna
4188 SA Hampton
4191 SA KangarooIsland
4192 SA Fleurieu
4201 SA SouthOlaryPlain_MurrayBasinSands
4202 SA MurrayMallee
4203 SA MurrayLakesandCoorong
4204 SA LowanMallee
4205 SA Wimmera
4237 SA Bridgewater
4238 SA GlenelgPlain
4239 SA Lucindale
4240 SA Tintinara
4266 SA Northernband_Carlisle
4267 SA Centralband_NullaborPlain
4268 SA Yalata
4286 SA MurrayScrollBelt
4308 SA SimpsonDesert
4309 SA Dieri
4310 SA Warriner
4311 SA StrzeleckiDesert_WesternDunefields
4314 SA Breakaways_StonyPlains
4315 SA Oodnadatta
4316 SA Murnpeowie
4317 SA PeakeDennisonInlier
4318 SA Macumba
4343 SA MountGambier
5010 WA AvonWheatbeltP1
5011 WA AvonWheatbeltP2
5064 WA CapeRange
5065 WA Wooramel
5077 WA Pentecost
5078 WA Hart
5079 WA MountEliza
5080 WA Mardabilla
5081 WA SouthernCross
5082 WA EasternGoldfield
5093 WA MannMusgraveBlock
5110 WA FitzroyTrough
5111 WA Pindanland
5131 WA Fitzgerald
5132 WA Recherche
5149 WA Ashburton
5150 WA Carnegie
5151 WA Augustus
5157 WA LateriticPlain
5158 WA DuneField
5161 WA Edel
5162 WA GeraldtonHills
5163 WA LeseurSandplain
5164 WA McLarty
5165 WA Mackay
5182 WA Shield
5183 WA Central
5184 WA Eastern_Maralinga
5185 WA Kintore

5188 WA Hampton
5189 WA NorthernJarrahForest
5190 WA SouthernJarrahForest
5194 WA Rudall
5195 WA Trainor
5199 WA EasternMallee
5200 WA WesternMallee
5231 WA EasternMurchison
5232 WA WesternMurchison
5260 WA Mitchell
5261 WA Berkeley
5266 WA Northernband_Carlisle
5267 WA Centralband_NullaborPlain
5272 WA Ord_OrdVictoriaPlainsP1
5273 WA SouthKimberleyInterzone
5277 WA Chichester
5278 WA Fortescue
5279 WA Hamersley
5280 WA Roebourne
5322 WA DandarraganPlateau
5323 WA Perth
5324 WA TanamiP1
5335 WA VictoriaBonaparteP1
5344 WA Warren
5406 WA Tallering
6053 TAS BenLomond
6148 TAS Flinders
6193 TAS King
6327 TAS CentralHighlands
6330 TAS NorthernMidlands
6331 TAS NorthernSlopes
6332 TAS SouthEast
6333 TAS SouthernRanges
6334 TAS West
7003 NT ArnhemCoastP1
7004 NT ArnhemCoastP2
7005 NT ArnhemCoastP3
7006 NT ArnhemCoastP4Groote
7007 NT ArnhemCoastP5Wessels
7008 NT ArnhemPlateauP1
7009 NT ArnhemPlateauP2
7058 NT BurtPlainP1
7059 NT BurtPlainP2
7060 NT BurtPlainP3
7061 NT BurtPlainP4
7062 NT CentralArnhemP1
7063 NT CentralArnhemP2
7066 NT TokoPlains
7093 NT MannMusgraveBlock
7105 NT DalyBasin
7106 NT DarwinCoastal
7112 NT DavenportMurchisonRangeP1
7113 NT DavenportMurchisonRangeP2
7114 NT DavenportMurchisonRangeP3
7138 NT FinkeP1
7139 NT FinkeP2
7140 NT Tieyon_FinkeP3
7159 NT McArthurSouthNicholsonBasins
7160 NT GulfFallandUplandsP2
7165 NT Mackay
7166 NT GreatSandyDesertP3
7167 NT GreatSandyDesertP4
7168 NT GreatSandyDesertP5
7169 NT GreatSandyDesertP6

7170 NT GulfCoastalP1

7171 NT GulfCoastalP2Pellews

7179 NT DoomadgeePlains

7196 NT MacDonnellRangesP1

7197 NT MacDonnellRangesP2

7198 NT MacDonnellRangesP3

7207 NT MitchellGrassDownsP1

7208 NT BarklyTableland

7209 NT GeorginaLimestone

7270 NT Thorntonia

7272 NT Ord_OrdVictoriaPlainsP1

7273 NT SouthKimberleyInterzone

7274 NT OrdVictoriaPlainsP3

7275 NT OrdVictoriaPlainsP4

7276 NT PineCreek

7307 NT SimpsonStrzeleckiDunefieldsP1

7308 NT SimpsonDesert

7309 NT Dieri

7314 NT Breakaways_StonyPlains

7318 NT Macumba

7319 NT SturtPlateauP1

7320 NT SturtPlateauP2

7321 NT SturtPlateauP3

7324 NT TanamiP1

7325 NT TanamiP2

7326 NT TanamiP3

7328 NT TiwiCobourgP1

7329 NT TiwiCobourgP2

7335 NT VictoriaBonaparteP1

7336 NT VictoriaBonaparteP2

7337 NT VictoriaBonaparteP3

8001 ACT AustralianAlps

8297 ACT SouthEasternHighlands

5.2 Historical Total & Percentiles for Rainfall (1998-2003)

Figure 5.1: Total Rain

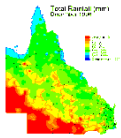
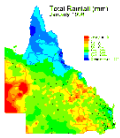
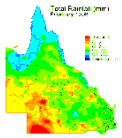
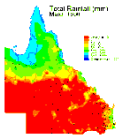
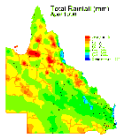
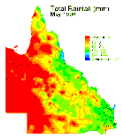
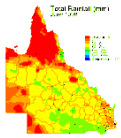
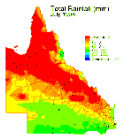
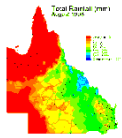
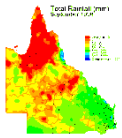
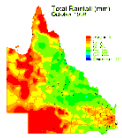
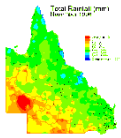
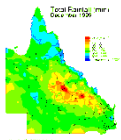
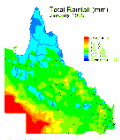
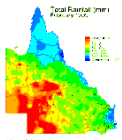
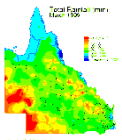
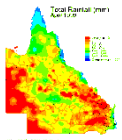
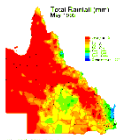
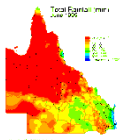
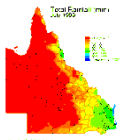
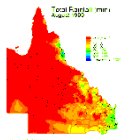
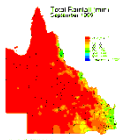
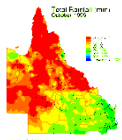
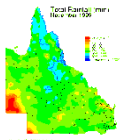
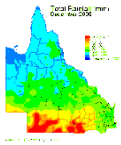
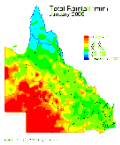
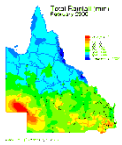
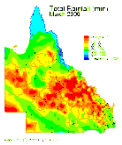
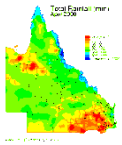
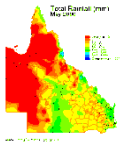
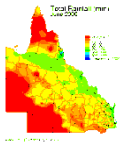
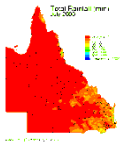
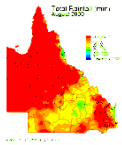
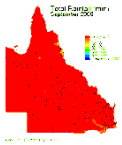
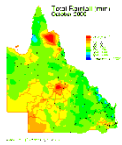
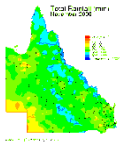
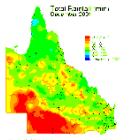
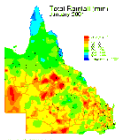
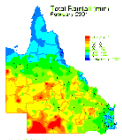
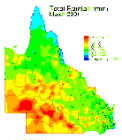
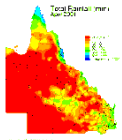
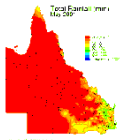
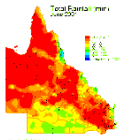
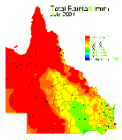
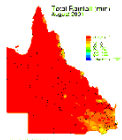
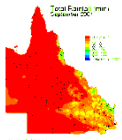
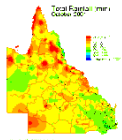
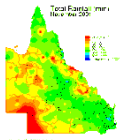
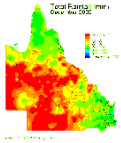
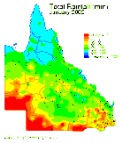
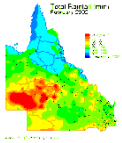
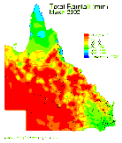
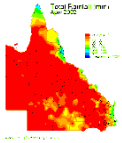
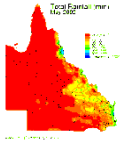
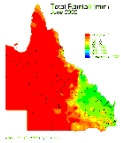
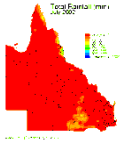
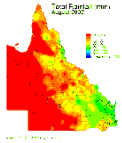
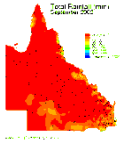
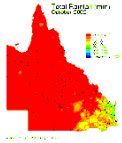
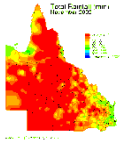
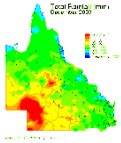
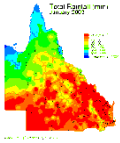
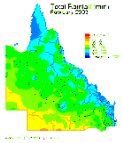
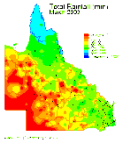
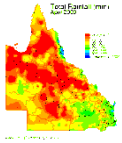
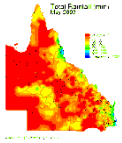
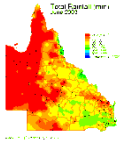
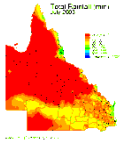
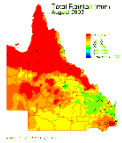
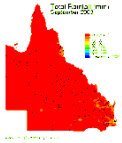
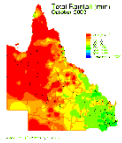
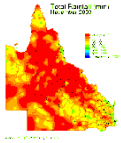
	Beg Jan	Beg Feb	Beg Mar	Beg Apr	Beg May	Beg Jun	Beg Jul	Beg Aug	Beg Sep	Beg Oct	Beg Nov	Beg Dec
	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1998												
1999												
2000												
2001												
2002												
2003												

Figure 5.2: 1 Month Percentile Rain

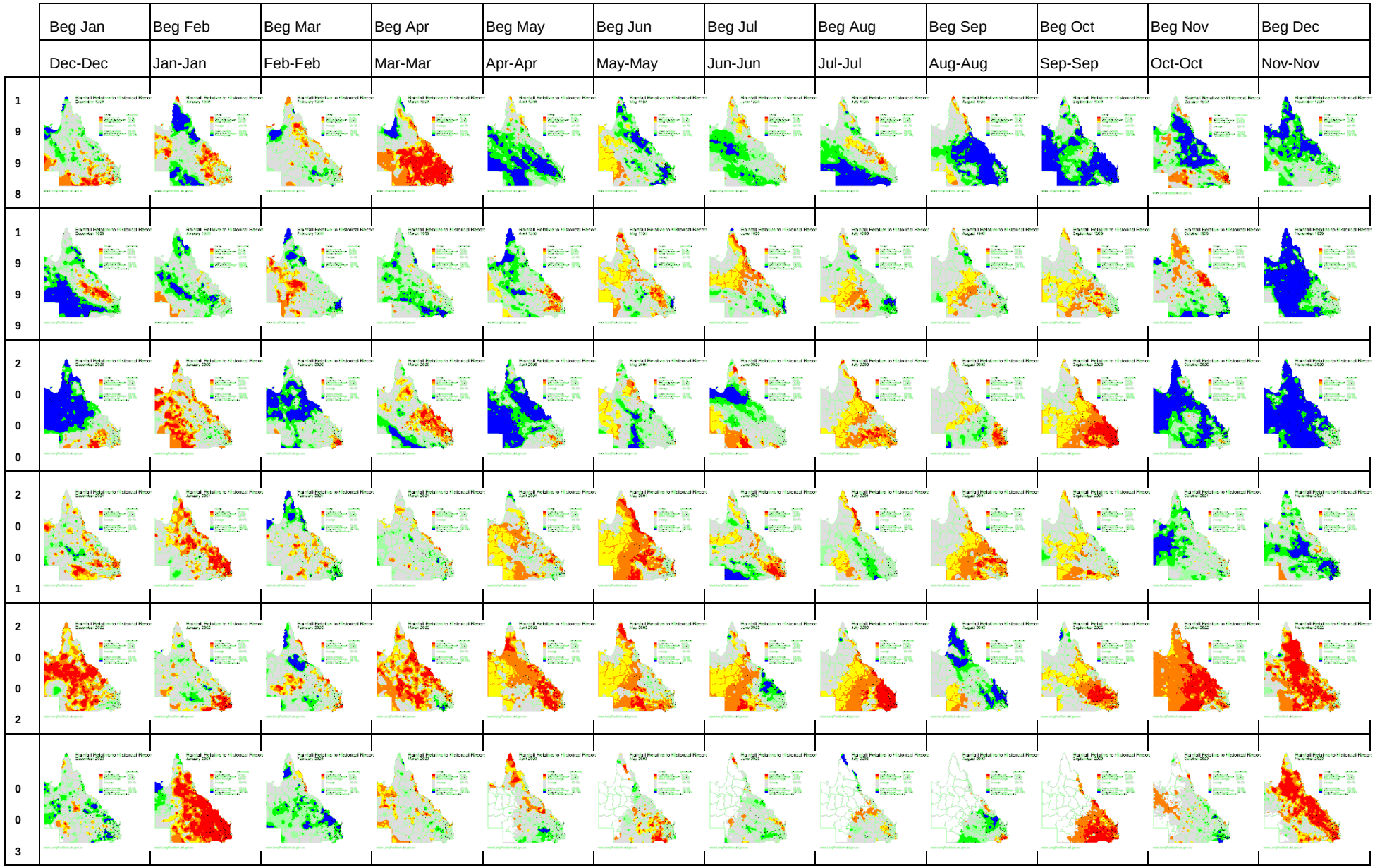


Figure 5.3: 3 Months Percentile Rain

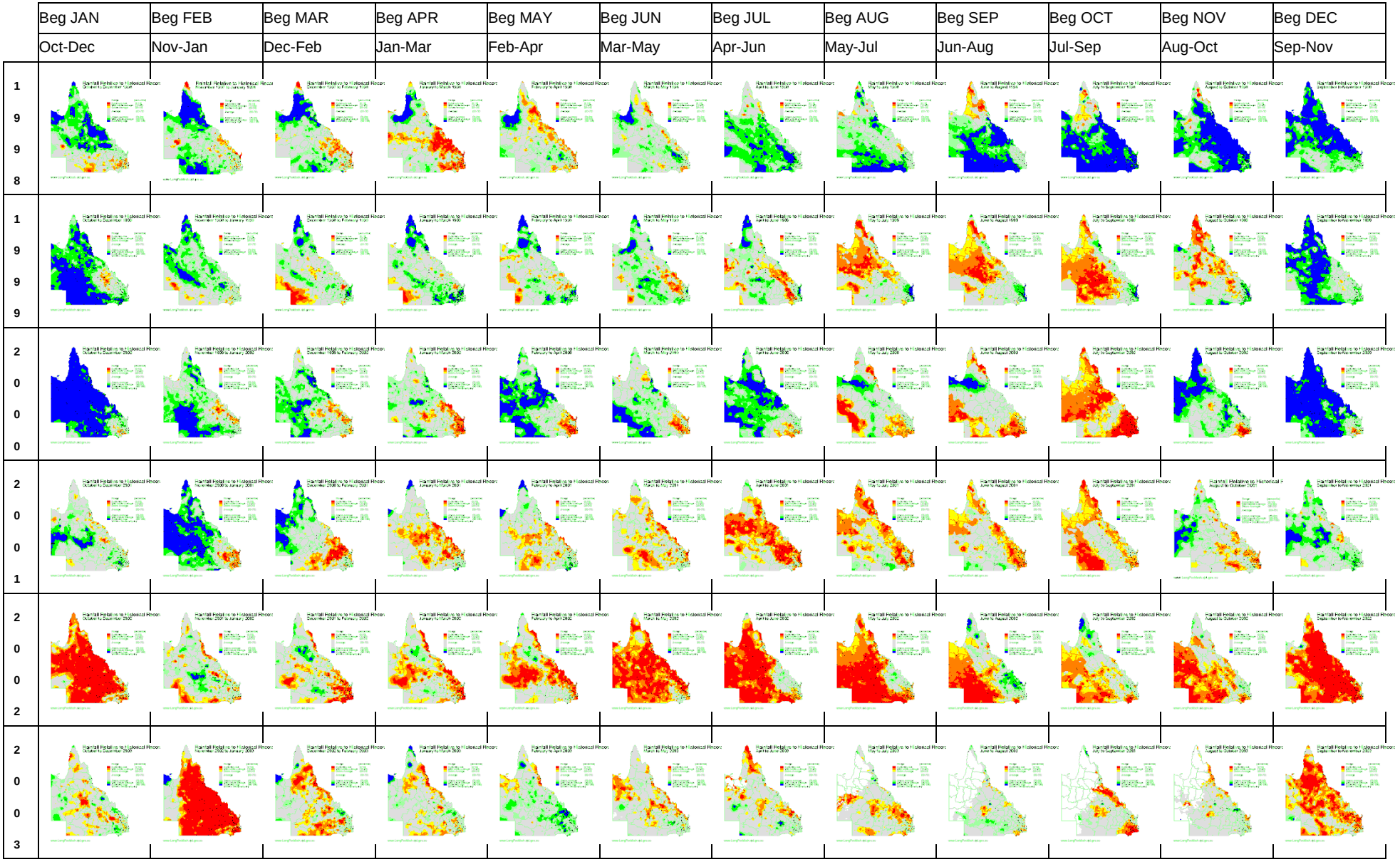


Figure 5.4: 6 Months Percentile Rain

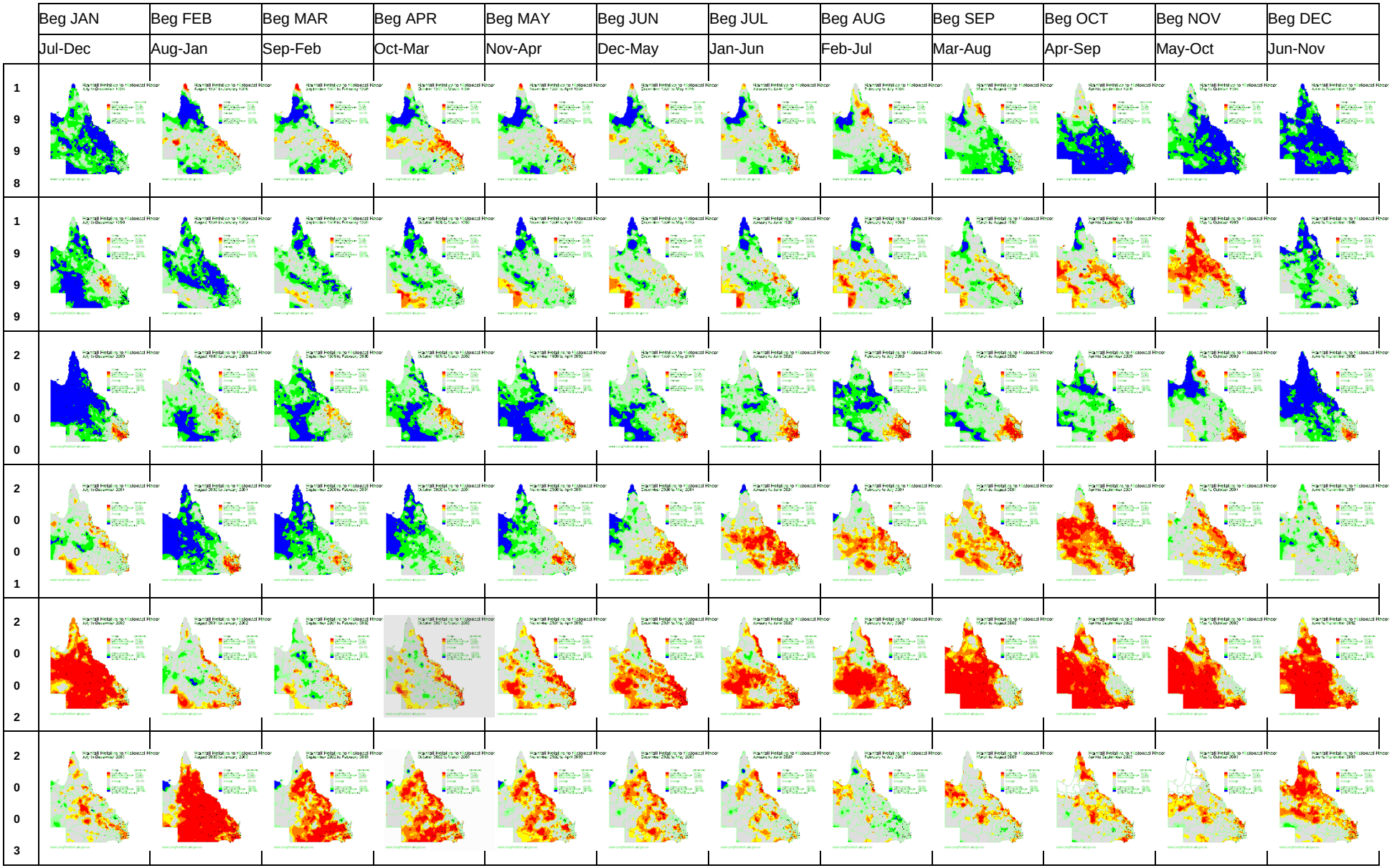


Figure 5.5: 12 Months Percentile Rain

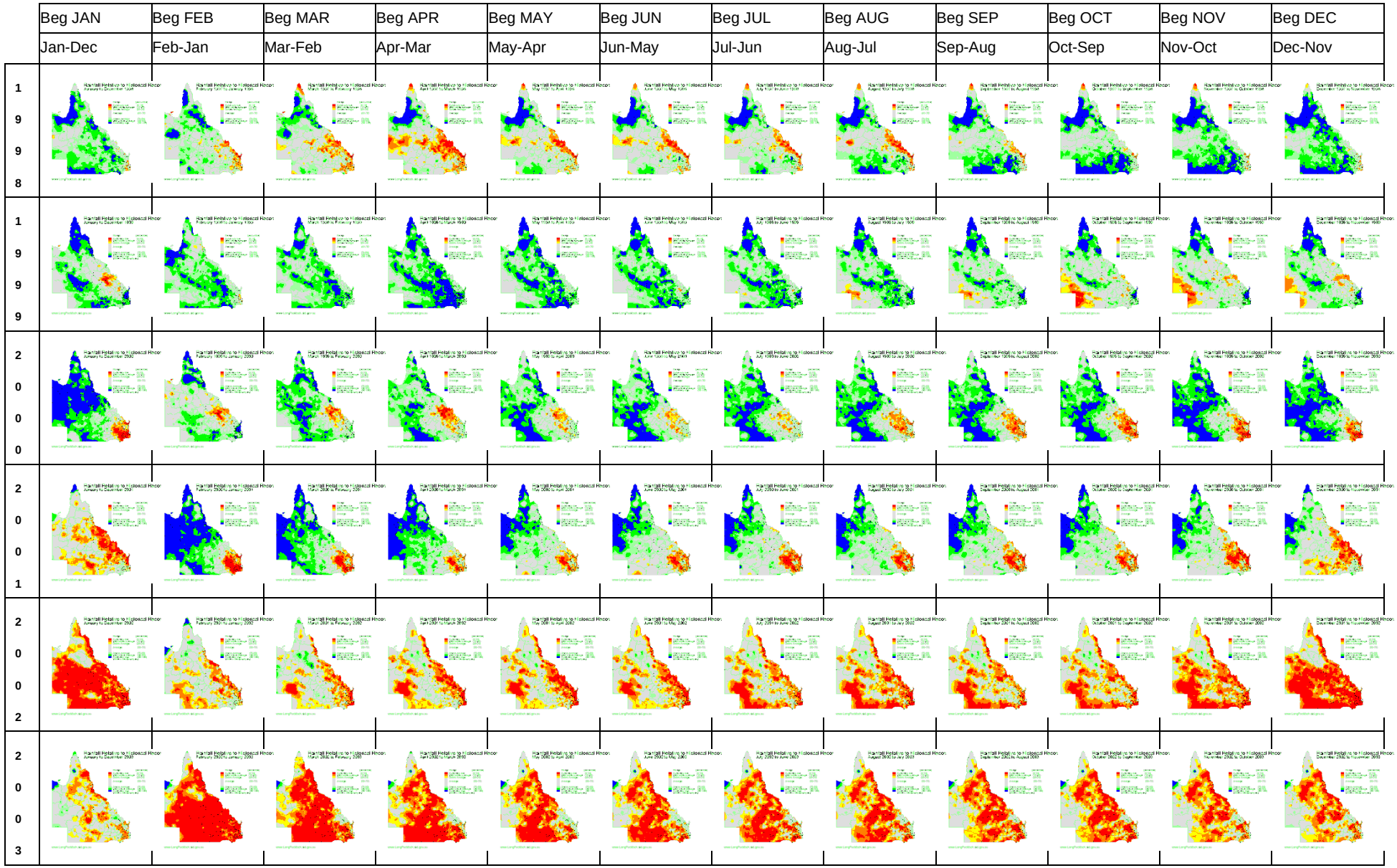


Figure 5.6: 24 Months Percentile Rain

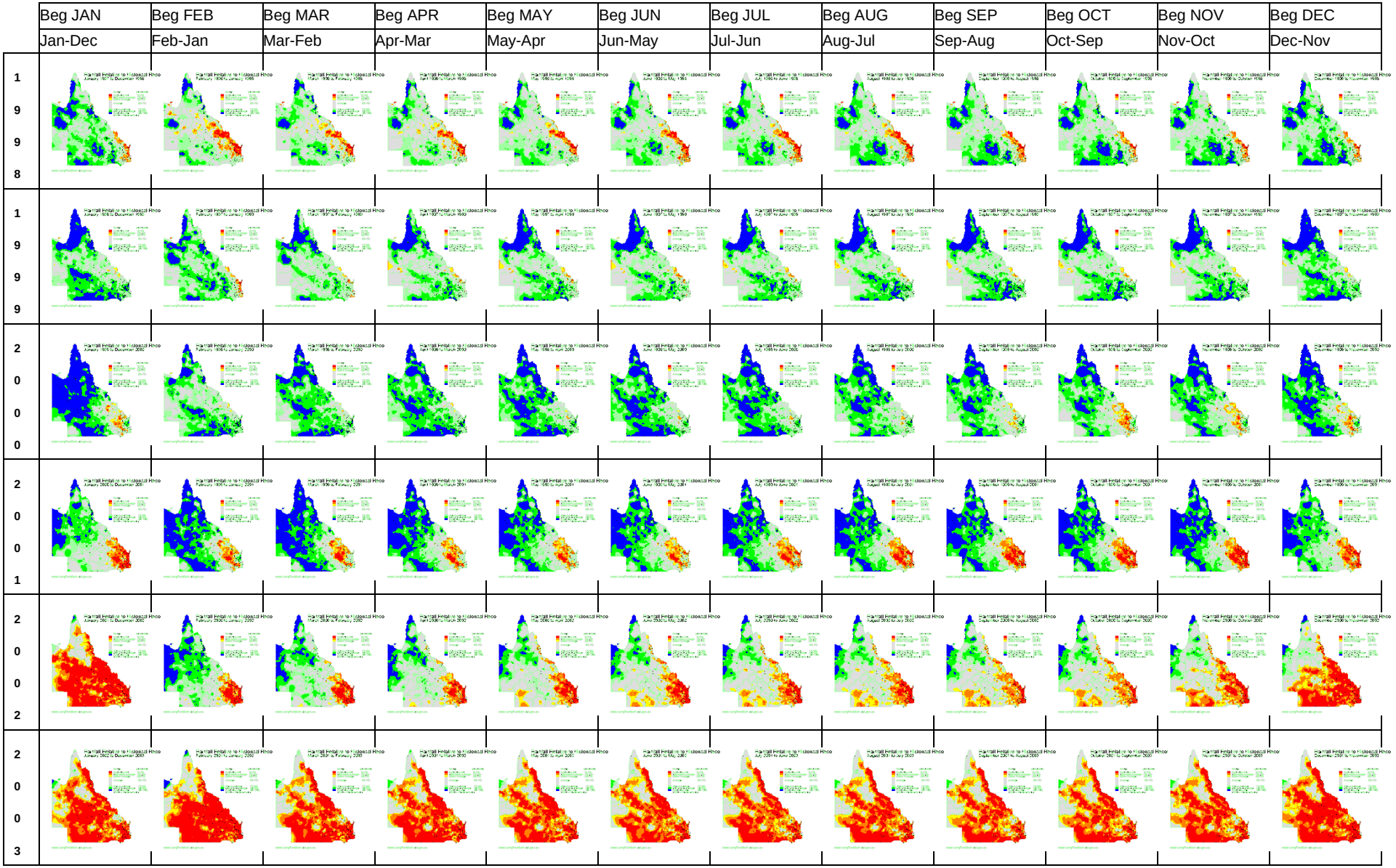
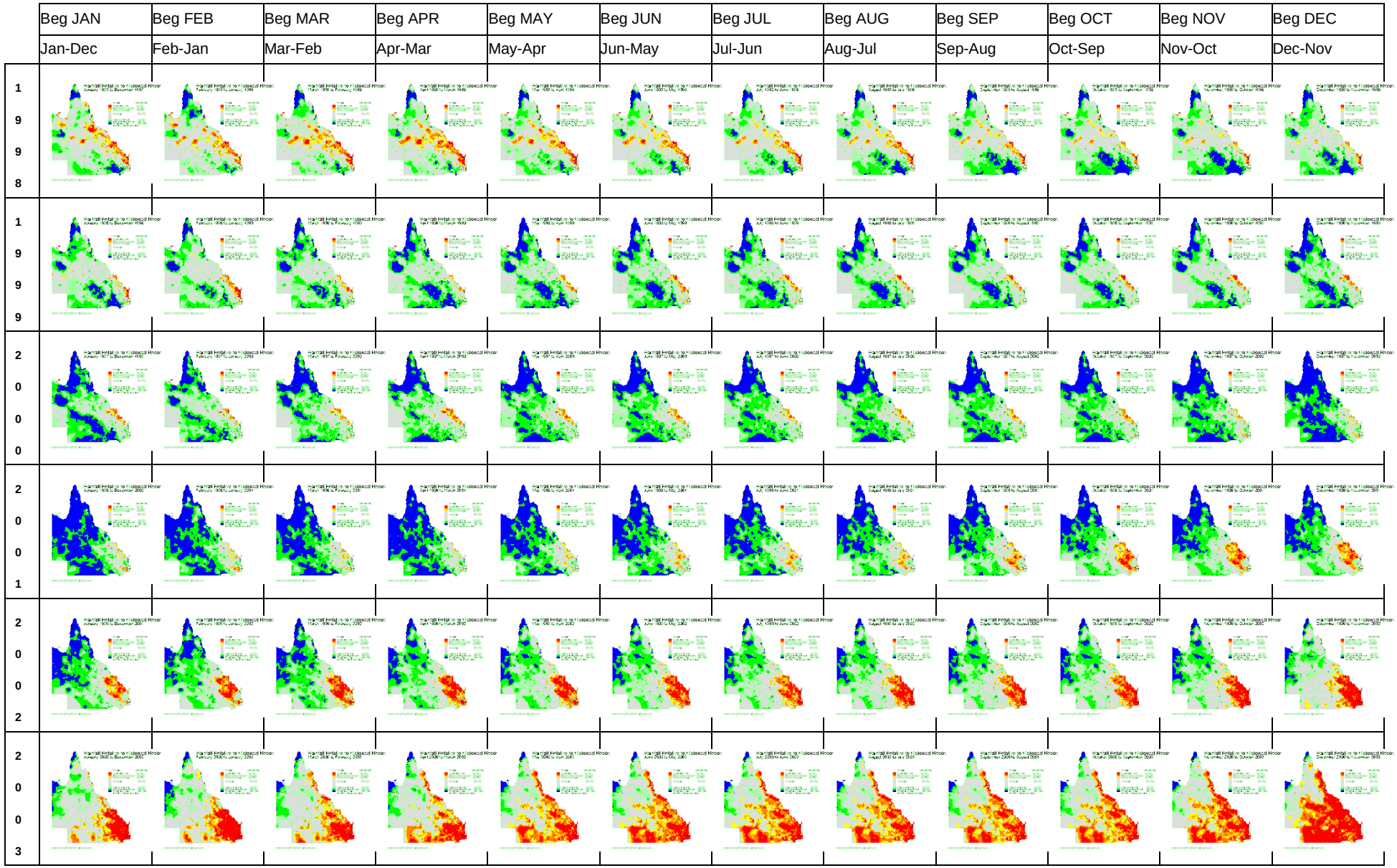


Figure 5.7: 36 Months Percentile Rain



5.3 Historical Total & Percentiles for Growth (1998-2003)

Figure 5.8: Total Growth

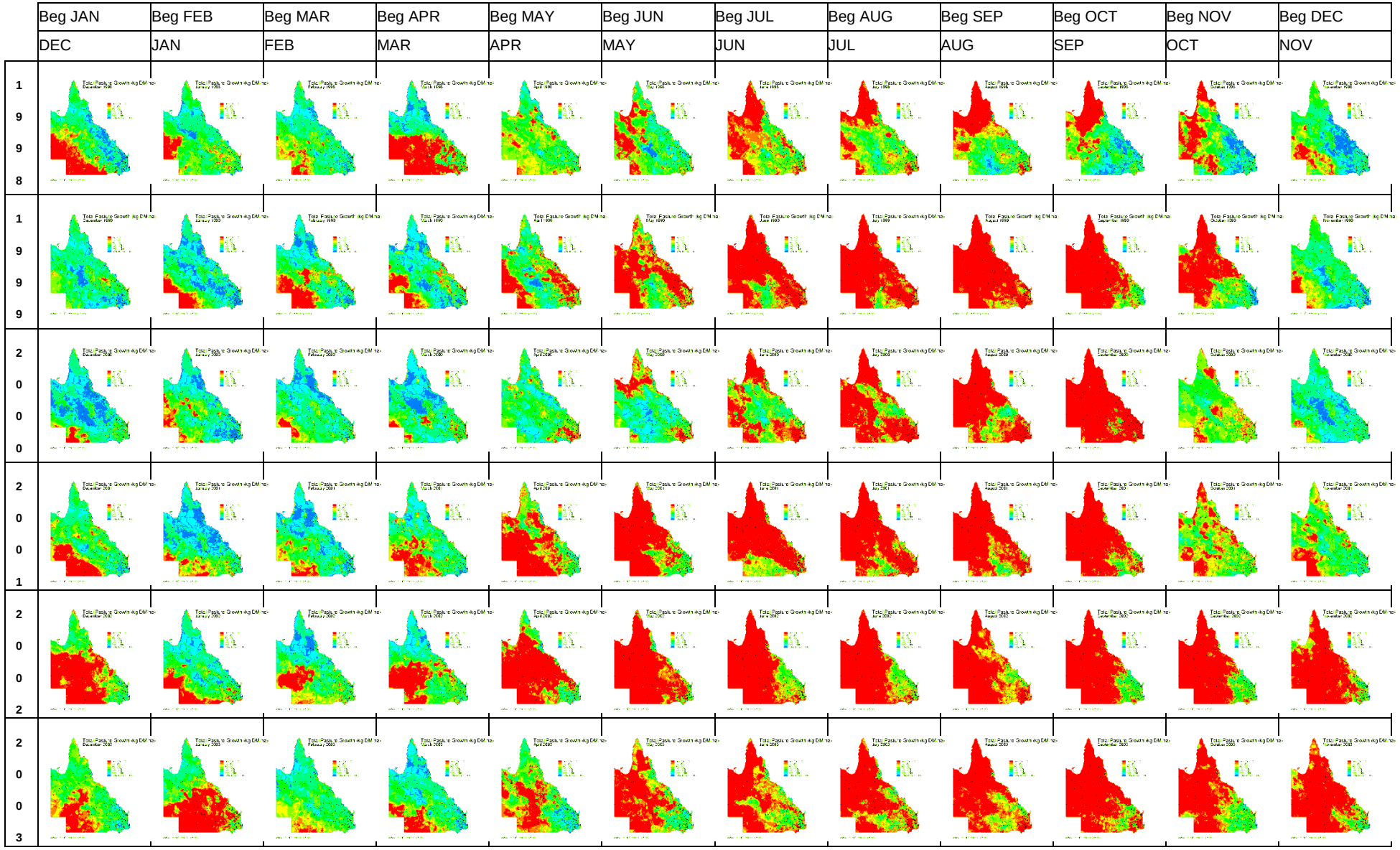


Figure 5.9: 1 Month Percentile Growth

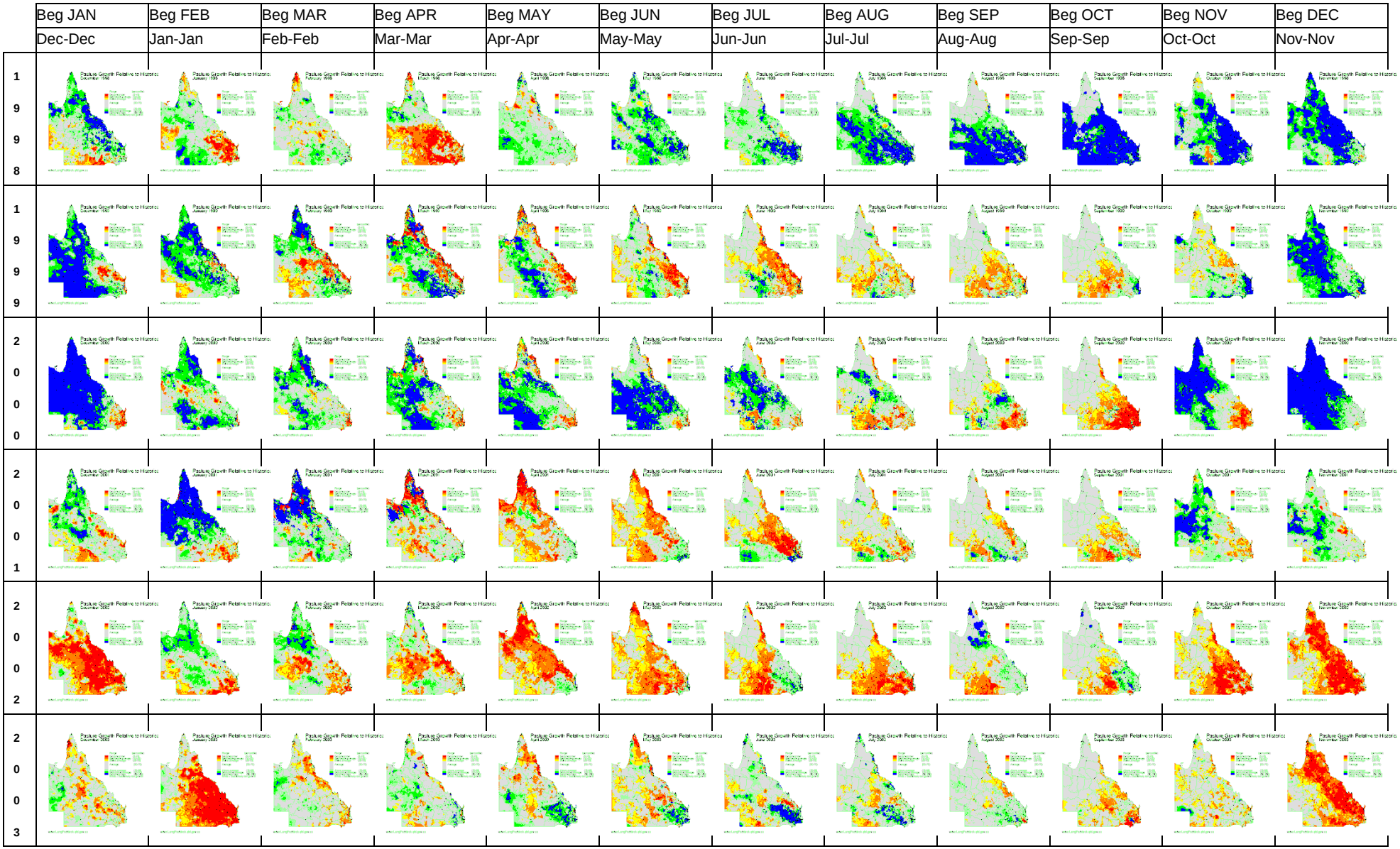


Figure 5.10: 3 Months Total Growth

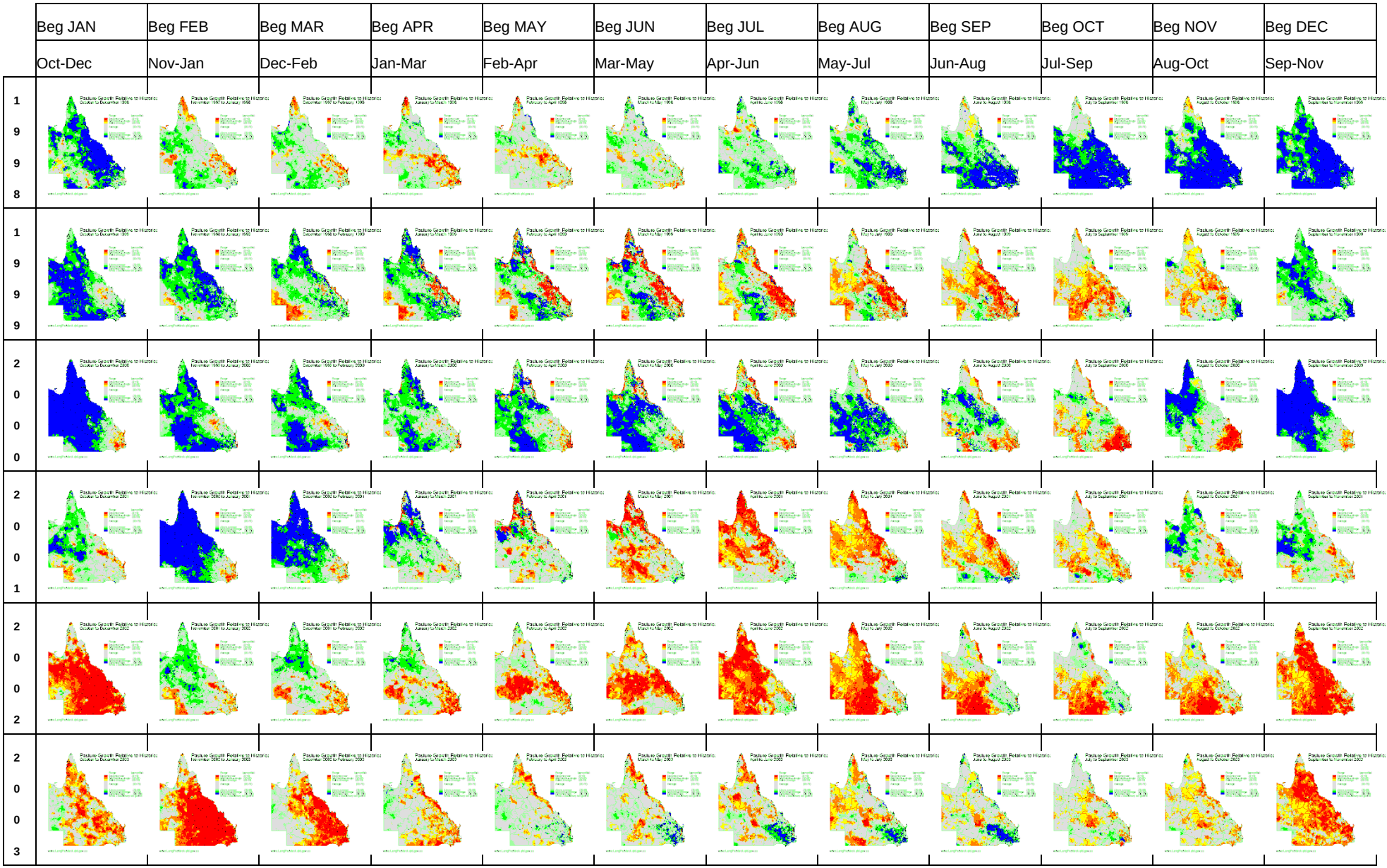


Figure 5.11: 6 Months Percentile Growth

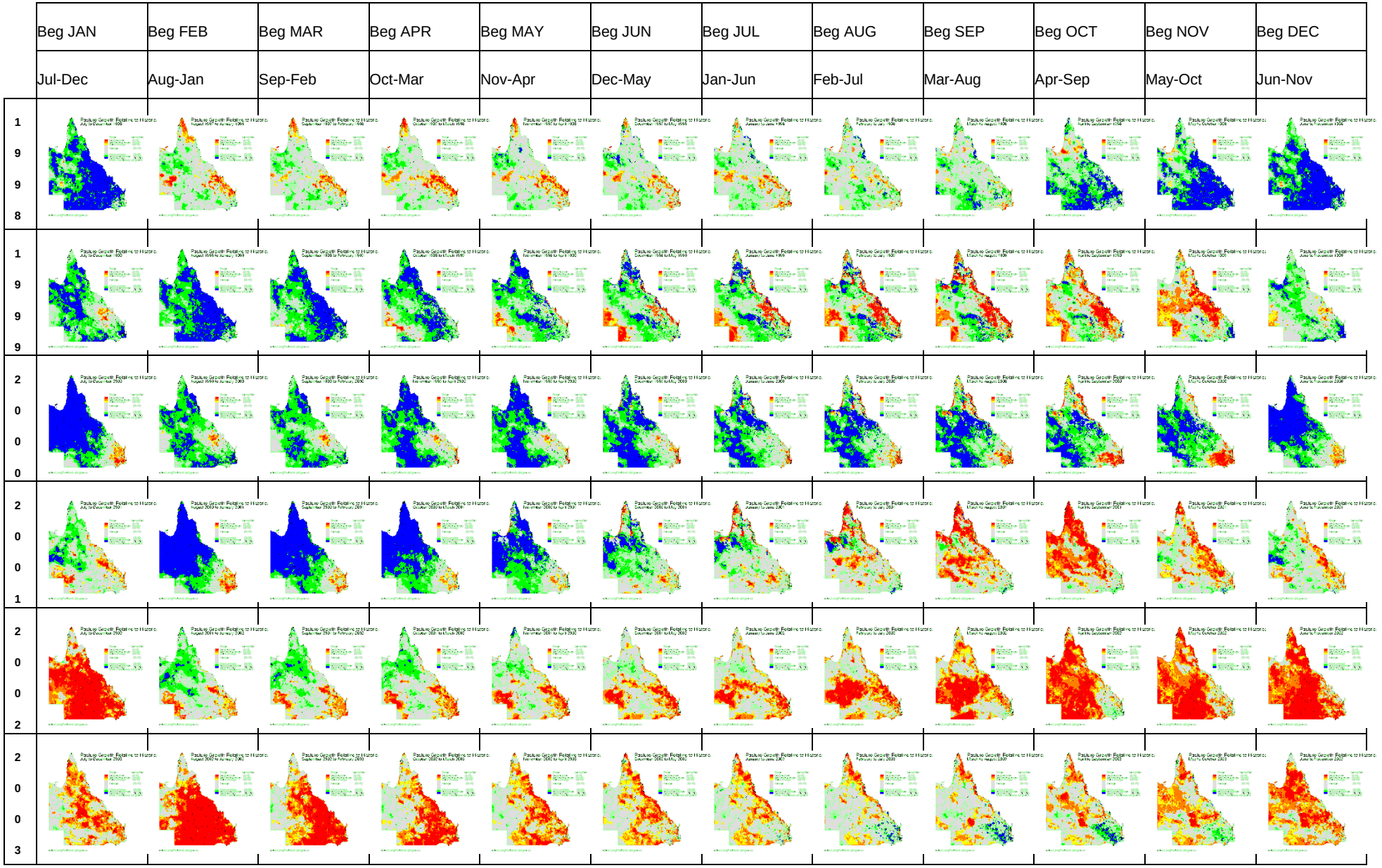


Figure 5.12: 12 Months Percentile Growth

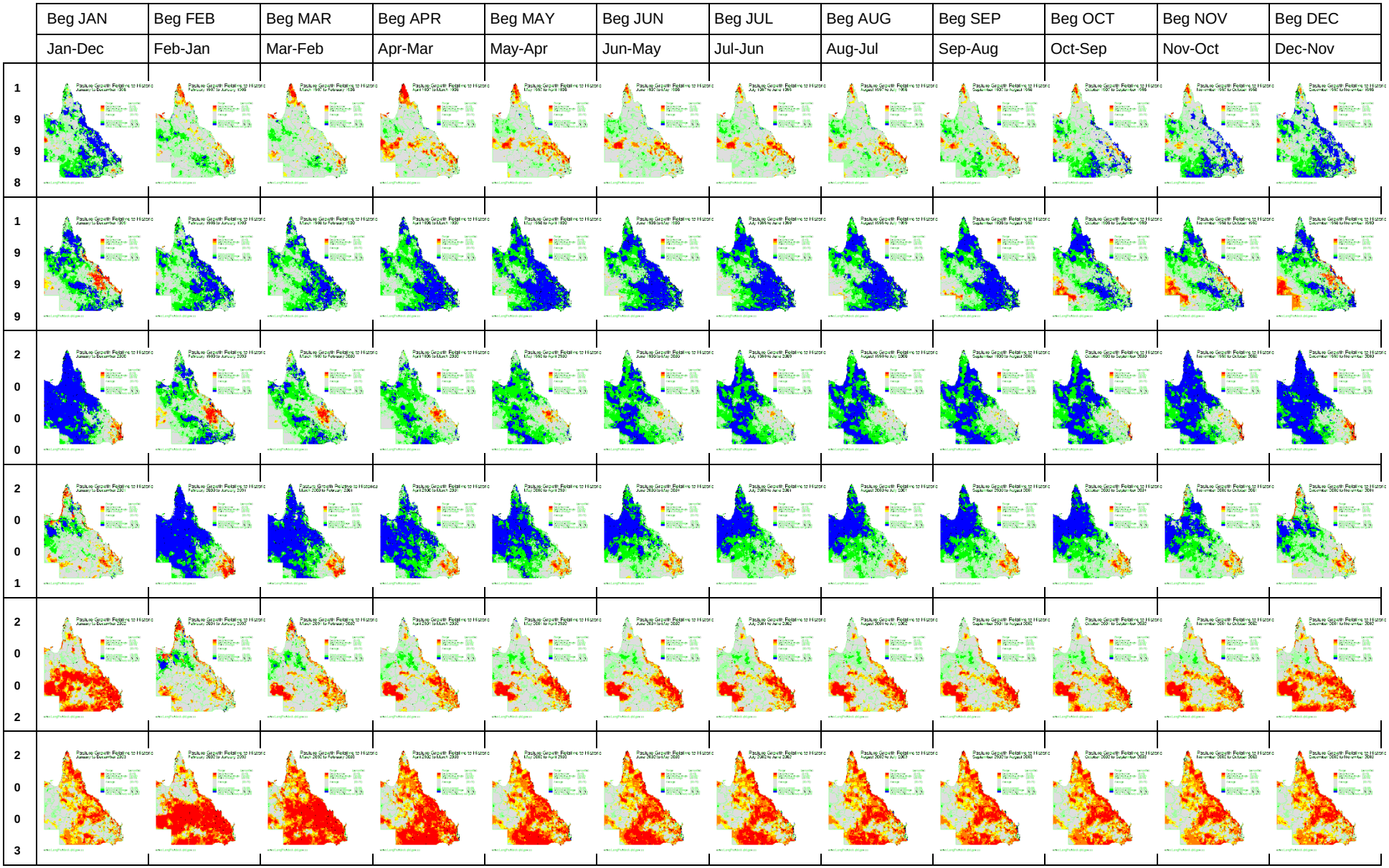


Figure 5.13: 24 Months Percentile Growth

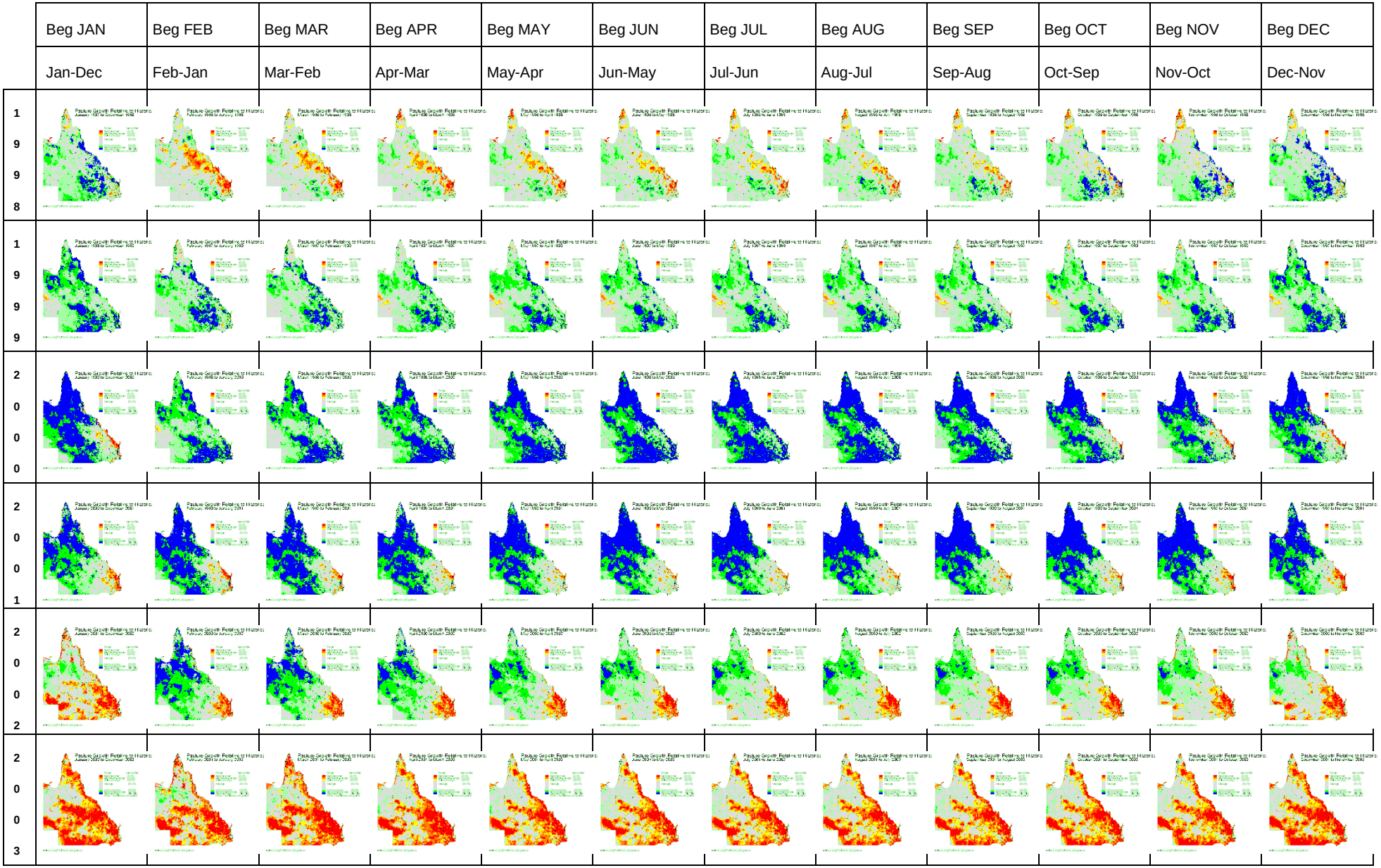
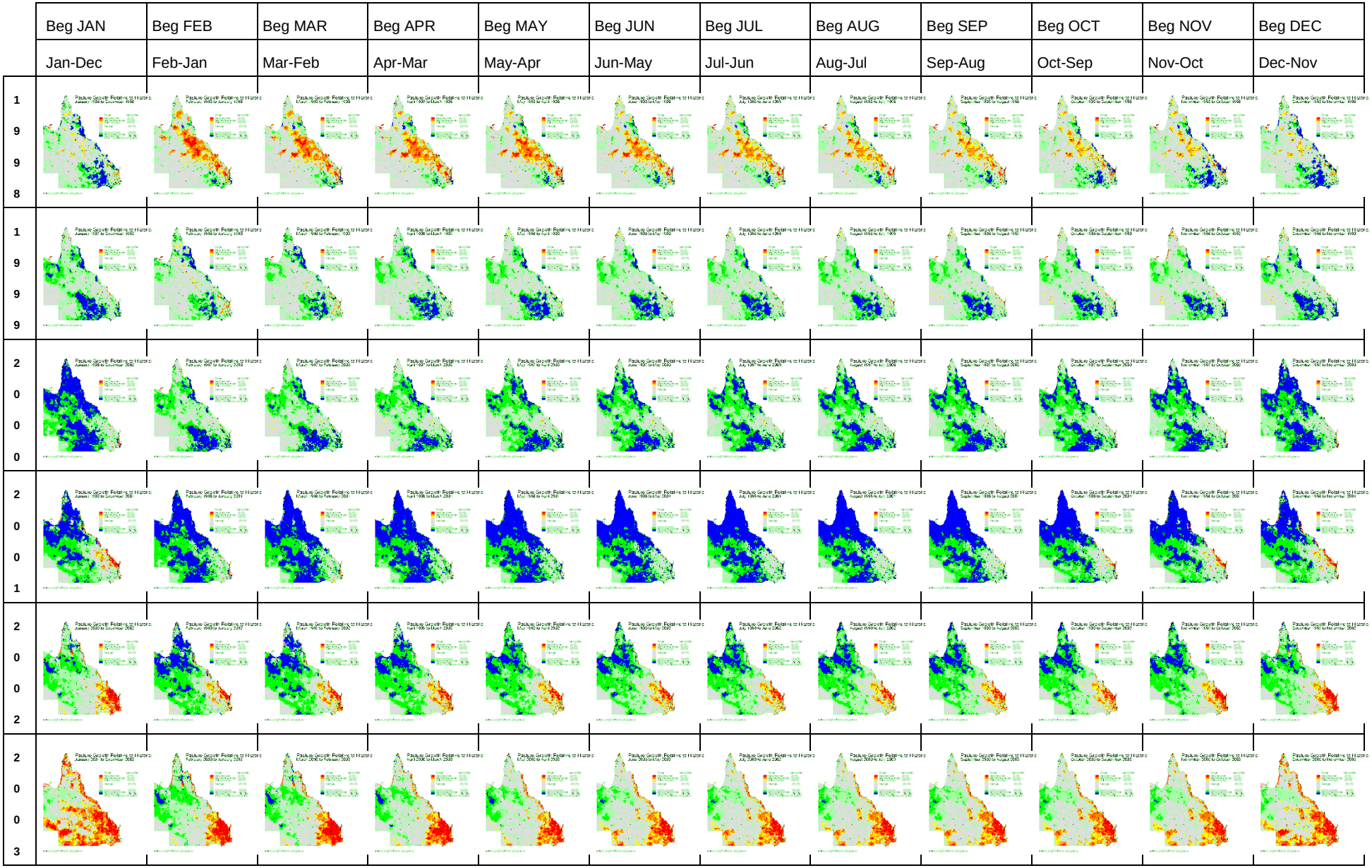
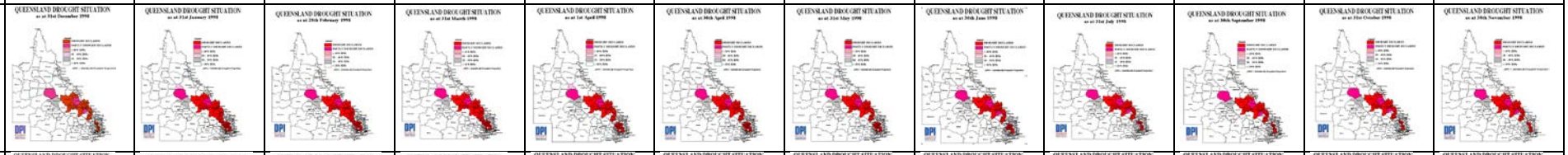
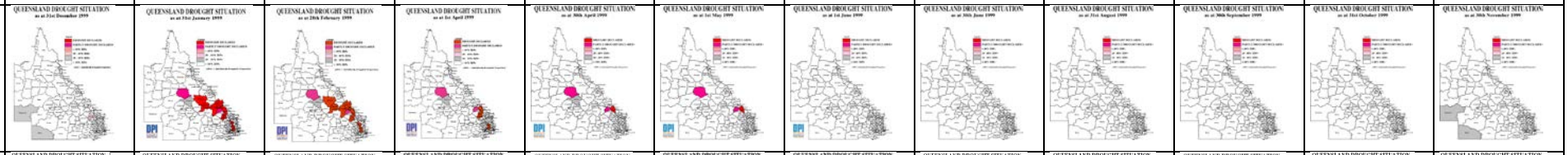
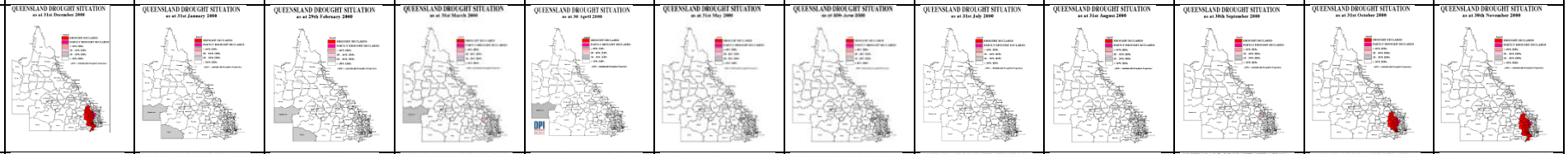
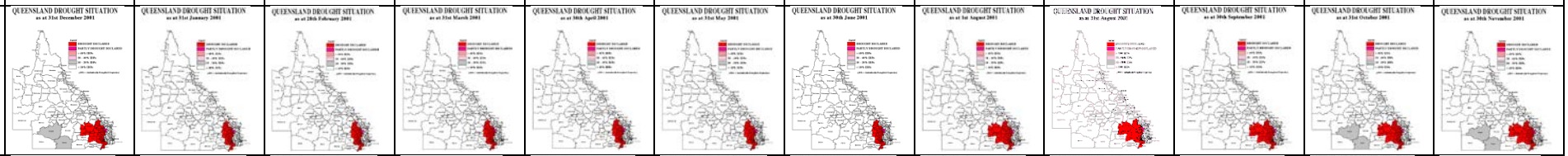
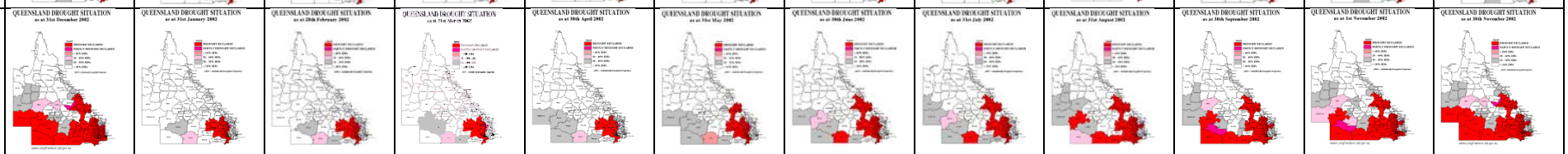


Figure 5.14: 36 Months Percentile Growth



5.4 Drought Maps

Figure 5.15: Drought Maps (https://www.longpaddock.qld.gov.au/queenslanddroughtmonitor/queenslanddroughtreport/index.php)

	Beg JAN	Beg FEB	Beg MAR	Beg APR	Beg MAY	Beg JUN	Beg JUL	Beg AUG	Beg SEP	Beg OCT	Beg NOV	Beg DEC
	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1998												
1999												
2000												
2001												
2002												
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